APPENDIX P: Local Hazard Mitigation Plans

CITY OF SANTA CRUZ
Local Hazard Mitigation Plan
Five Year Update
2018–2023

Hazard Mitigation is any action taken to reduce or eliminate the long-term risk to human life and property from hazards.
~ Title 44 Code of Federal Regulations (§206.401)

Adopted by the City
Council October 9, 2018

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How to Use This Plan

FEMA has defined very specific requirements for Local Hazard Mitigation Plans and this plan follows those guidelines. The organization of the Plan follows FEMA's structural requirements and includes the following four organizational levels:

- Parts
- Chapters
- Sections
- Subsections

This LHMP Five Year Update [2018–2023] is organized into five primary Parts and fifteen Chapters (and, Appendices A–R), that track the phases of the plan's development as follows:

Risk Assessment (Part 3) is organized into specific hazards by chapter (Chapter 4 through Chapter 12). Within each of these chapters all elements required by the FEMA *Local Mitigation Review Tool* (formerly, the "crosswalk"), are addressed and the sections and subsections of each of these chapters follow the section numbering of the Local Mitigation Plan Review Tool. The Local Mitigation Plan Review Tool elements are formatted in this document as follows:

Subsection **3.1 Identifying Risk Hazards is §7.3.1** in Chapter 7 – Drought

Each of the specific hazard Risk Assessment chapters contains the following subsections:

- **3.0 Risk Assessment**
    - 3.1 Hazard Identification
    - 3.2 Hazard Profile including subsections on location, extent, previous occurrences and probability of future events.
    - 3.3 Assessing Vulnerability
    - 3.4 Identifying Structures
    - 3.5 Estimating Potential Losses

- ♦ 3.6 Analyzing Development Trends

Mitigation Strategy (§4.0 through §4.2) is addressed briefly under each hazard chapter and covered comprehensively in Part 4. Goals and Actions specific to a particular hazard are included within each of the hazard chapters and are labeled by hazard (e.g., Earthquake Goal 1, etc.). Goals, Objectives and Actions which apply to one or more potential hazards are listed in Part 4.

Specific **Mitigation Actions** are noted throughout the hazard chapters as, for example, (A-1), and are cross-referenced to Chapter 13, Mitigation Strategy.

Goals, **Objectives** and **Action** items identified as part of the mitigation strategy were formulated in collaboration with the departments responsible for implementation of the actions. These goals and supporting actions are not new but have been taken from various plans adopted by the City Council including the General Plan Safety Element, the Capital Improvement Project list, the 2015 Urban Water Management Plan, the Emergency Operations Plan (2013) and several fire safety plans, the 2011 Climate Adaptation Plan and its update (2017; appended to this LHMP). This material was revisited and addressed during the current update process.

Local Mitigation Plan Review Tool sections that do not apply to the City of Santa Cruz, such as multi-jurisdiction plan requirements, are not included.

Terminology — A note on terminology related to “probabilities” of natural disaster occurrences:

The following terms are found in the LHMP for natural disasters:

- Very likely / Definite
- Likely / Probable
- Not likely / Unlikely / Questionable
- Extremely unlikely

The terms below, relative to “likelihood” within certain time frames, are noted by our jurisdiction to have the following percentage values:

Terms used in the Local Hazard Mitigation Plan

• Very likely / Definite	Each five (5) years = 20% chance in any given year
• Likely / Probable	Each ten (10) years = 10% chance in any given year
• Not likely / Unlikely / Questionable	Each five (5) years = 5% chance in any given year
• Extremely unlikely	Each 100 years = 1% chance in any given year

Impact Statements — Mention is made, in various Chapters, of impacts from natural hazards as they relate to loss of property, damage to the environment and also the number of residents impacted by those natural disasters. In this document, specific numbers relating to (how many) deaths and injuries, damage to structures and infrastructure, costs and impacts related to environmental damage, economic hardships, loss of operations, impacts to tourism, etc., are not stated as they have not been studied and are unknown at this time. Readers should gauge such impacts based on the material presented for each natural disaster. Further study may be introduced in future iterations of this LHMP.

Compliance with the Code of Federal Regulations

Each part of the LHMP includes required elements specified under Section 201.6 of Title 44 of the Code of Federal Regulations (44 CFR). Since one of the objectives established for the LHMP is to achieve compliance for the City of Santa Cruz under the Disaster Mitigation Act (DMA), the requirements specified for program compliance are often cited at the beginning of a subsection to illustrate how that subsection attempts to comply with the requirement.

Section 44 CFR 44 CFR §201.6(d)(3) reads:

> *A local jurisdiction must review and revise its plan to reflect changes in development, progress in local mitigation efforts, and changes in priorities, and resubmit it for approval within five (5) years in order to continue to be eligible for mitigation project grant funding.*

Appendices

At the end of this LHMP are Appendices A–R. These appendices include vital information or explanations to support the main content of this plan. Technical terms, acronyms, and abbreviations are used throughout this document. To aid the reader, technical terms used in the LHMP and, in emergency management in general, are defined in the glossary. The list of acronyms and abbreviations defines all shortened forms used in Hazard Mitigation planning and/or this LHMP.

Climate Adaptation

The City of Santa Cruz Climate Adaptation Plan, adopted by the City Council (Resolution NS-28,435, December 13, 2011), is referenced throughout this LHMP Update where appropriate and where it is relevant to identified vulnerabilities and risks. Additionally, the 2017 Climate Adaptation Plan Update, having been updated concurrently to this Five Year LHMP Update, is annexed in its entirety to this document in the Appendices (*see* Appendix P).

The LHMP benefited greatly from the public outreach that was undertaken in the development of the 2011 Climate Adaptation Plan. In fact, the Climate Adaptation Plan was intended to be the City's initial LHMP Five Year Update and its development was managed as such. Chapter 15 details the public outreach and Plan Update efforts undertaken by the LHMP/Climate Adaptation Project Team.

PART 1 — INTRODUCTION AND ADOPTION

Prerequisites

- Introduction
- Acknowledgements
- City Council Resolution Adopting Plan
- Summary

Introduction

THIS PLAN IS AN UPDATE

In 2007 the City of Santa Cruz completed and adopted its first Local Hazard Mitigation Plan (LHMP). Late in 2012 and early 2013 the LHMP was updated, approved by the California Office of Emergency Service (formerly CalEMA) and then by the Federal Emergency Management Agency (FEMA). The City Council formally adopted the Plan on June 24, 2014.

The Disaster Mitigation Act of 2000 (DMA, Section 201.6(c)(4)(i) requires a Plan Maintenance Process which includes periodically reviewing and updating hazard mitigation plans. FEMA requires jurisdictions to update their LHMP every five years, subject to approval by the California Office of Emergency Services (CalOES). An approved and adopted LHMP is required for the City of Santa Cruz to receive future federal and state emergency funding.

This document is the **City of Santa Cruz 2018–2023 LHMP Five Year Update**. It is the second five year update undertaken by the City. Chapter 3: The Planning Process, details how the City of Santa Cruz planned and managed this update.

The intent of the current Plan, while incorporating much of the prior LHMP versions, is to:

- Include any newly identified hazards
- Update hazard/risk data
- Update development data
- Review and revise as necessary the original document's Goals, Actions and Implementation Strategies
- Update demographic data and maps, based on current information
- Incorporate findings from the City of Santa Cruz Climate Adaptation Plan (CAP):
    - Adopted by City Council (Resolution NS-28,435, December 13, 2011)
    - The CAP is being updated concurrently with this LHMP

LOCAL HAZARDS

People and property in Santa Cruz are at risk from a variety of hazards which have the potential to precipitate wide spread loss of life, damage to property, infrastructure and the environment. Some hazards are natural, such as earthquakes, others are natural hazards exacerbated by the use of land, such as building along the cliff and development within floodplains. A natural hazard can result in damages and hardships for an entire community for many years following the event. Flooding, drought, earthquakes and cliff retreat have all occurred in the City of Santa Cruz within the last fifty years. Until 1989, flooding on the San Lorenzo River had caused the most severe damage in the City. However, the Loma Prieta earthquake in 1989 changed that history. Although subject to droughts, the City will experience flood conditions in the future. There is a very strong possibility of an earthquake equal to or larger than the Loma Prieta quake occurring in the Santa Cruz area (*see* Table 4-2).

The City of Santa Cruz is somewhat unique in that water service is provided by the Water Department to an area beyond the city limits and a significant portion of the water service infrastructure extends outside the city limits including the primary ground storage facility, Loch Lomond Reservoir.

Although Santa Cruz is a city of ± 64,632 residents (Department of Finance 2015 estimate; http://www.dof.ca.gov), this hazard mitigation plan impacts approximately 96,100 people inside *and* outside the city limits because of the city water service boundaries.

HAZARD MITIGATION

The purpose of hazard mitigation is to implement and sustain actions that reduce vulnerability and risk from hazards, or reduce the severity of the effects of hazards on people and property.

Mitigation actions include both short-term and long-term activities which reduce the impacts of hazards, reduce exposure to hazards, or reduce effects of hazards through various means including preparedness, response and recovery measures. Effective mitigation actions also reduce the adverse impacts and cost of future disasters.

The City of Santa Cruz developed a Local Hazard Mitigation Plan (2007–2012) and an initial Five Year Update (2012–2017), to create a safer community. The LHMP represents the city's commitment to reduce risks from natural and other hazards, and serves as a guide for decision-makers as they commit resources toward reducing the effects of potential hazards. The LHMP serves as a basis for the California Office of Emergency Services to provide technical assistance and to prioritize project funding. (Code of Federal Regulations [CFR] §201.6.).

The City of Santa Cruz must have an approved LHMP pursuant to CFR §201.6 in order to receive FEMA Pre-Disaster Mitigation (PDM) project grants or to receive post-disaster Hazard Mitigation Grant Program (HMGP) project funding. This LHMP Five Year Update (2018–2023) is written to meet the statutory requirements of the Disaster Mitigation Act 2000, enacted October 30, 2000 and Title 44 of the Code of Federal Regulations CFR Part 201 – Mitigation Planning, Interim Final Rule, published February 26, 2002.

Acknowledgements

NOTE: Many of the following individuals contributed to the original LHMP (2007–2012), its first update (2012–2017), as well as to the current document (2018–2023). This information is updated as of February 2018.

2018 City of Santa Cruz City Council			
David Terrazas	Mayor	Sandy Brown	Cynthia Mathews
Martine Watkins	Vice-Mayor	Christopher Krohn	Richelle Noroyan
			Cynthia Chase

2018 LHMP Project Team/Staff	**Department**	**Position**
Robert Solick (LHMP)	Fire	Mgmt. Professional and Technical Assistant
Tiffany Wise-West (CAP)	City Manager	Sustainability and Climate Action Coordinator
Chris Schneiter	Public Works	Assistant Director/City Engineer
Steve Wolfman	Public Works	Senior Associate Civil Engineer
Paul Horvat	Fire	Principal Management Analyst/OES
Michele King (ret.)	Planning	Senior Planner
Maya Crelan Ray	Planning	Professional and Technical Assistant
Carol Scurich	Parks and Recreation	Recreation Superintendent
Monica Rubio	Parks and Recreation	Parks Superintendent
Leslie Keedy	Parks and Recreation	Urban Forester
Heidi Luckenbach	Water	Deputy Director/Operations Manager
Toby Goddard	Water	Water Conservation Manager
Katie Moore	Water	Associate Planner II
Taylor Roone	Water	Associate Civil Engineer
Joe Hall (ret.)	Economic Development	Project Manager
Rebecca Unitt	Economic Development	Economic Development Coordinator
Richard Westfall	Information Technology	Systems Coordinator (GIS, IT, HAZUS)
2018 LHMP Technical Advisors	**Organization**	**Position**
Climate Adaptation Vulnerability Assessment		
Ross Clark	Central Coast Watershed Group	Program Director
Sarah Stoner-Duncan	Central Coast Watershed Group	Research Associate
Dr. Juliano Calil	UCSC Ocean Sciences	Research Scientist
Dr. Ben Preston	Rand Corporation	Policy Researcher, Sr.; Director, Infrastructure Resilience and Environmental Policy Program
Greg Pepping	Coastal Watershed Council	Executive Director
Dr. Bill Henry	Groundswell Coastal Ecology	Founding Dir. of Groundswell Coastal Ecology
Stakeholders		
Rosemary Anderson	Santa Cruz County OES	Emergency Services Manager

Summary

Surrounded by greenbelt and the Pacific Ocean, Santa Cruz is a compact, vibrant beach community that preserves the diversity and quality of its natural and built environments, creates a satisfying quality of life for its diverse population and workers, and attracts visitors from around the world. But every aspect of the city — its economic prosperity, social and cultural diversity, scenic beauty and historical character — could be dramatically altered by a serious earthquake, flood, tsunami or fire.

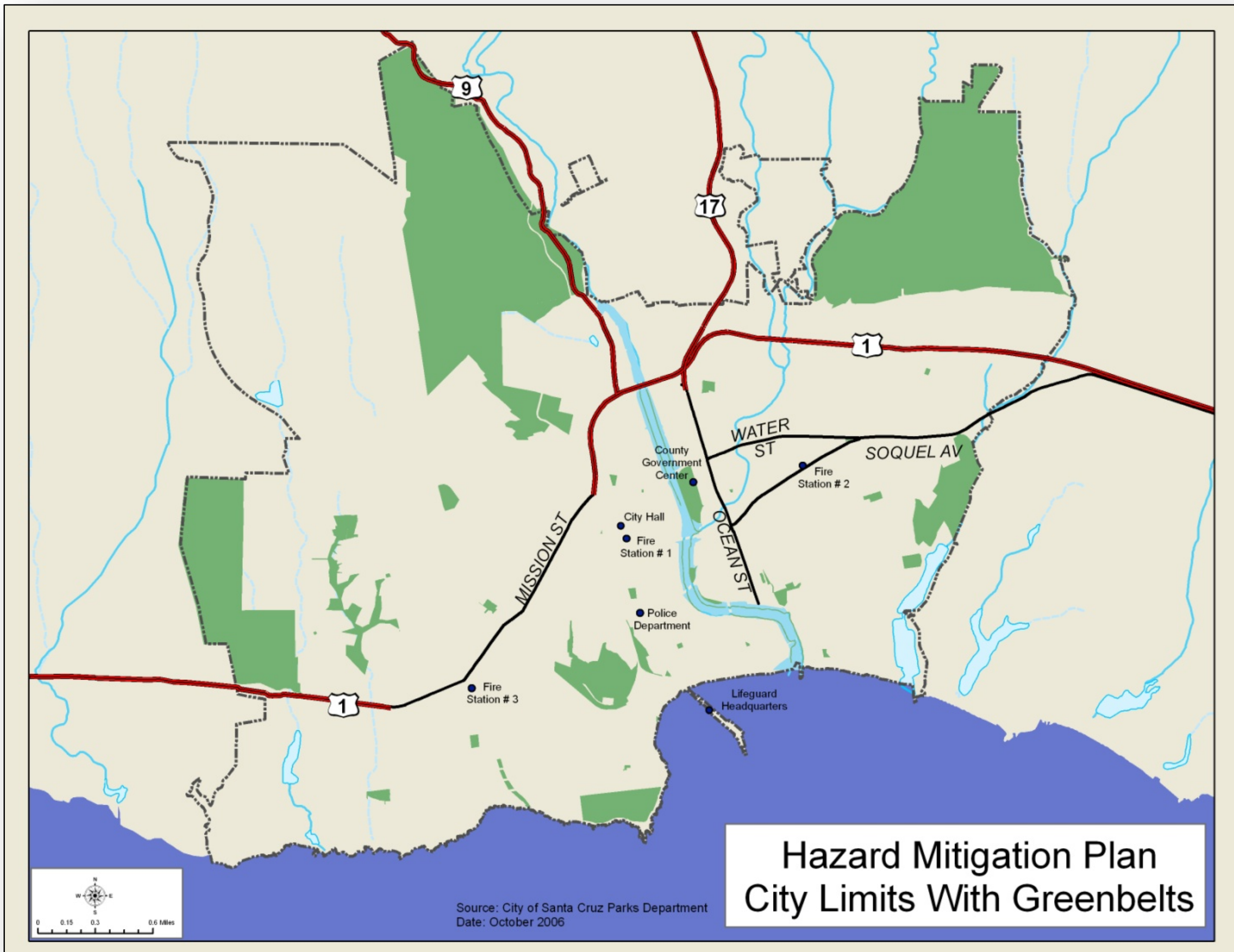


Figure 1 – City Limits of Santa Cruz with Surrounding Greenbelts

Source: City of Santa Cruz GIS 2017

Natural hazards that have affected Santa Cruz in the past and those that may affect it in the future can be identified with a high degree of probability. However, the future extent of these hazards is unknown. Flooding, earthquakes and cliff retreat have all occurred in the city within the past forty years. The city is prone to reoccurring droughts and the city will periodically witness flood conditions in the future. Until 1989, flooding on the San Lorenzo River had caused the most severe damage in the city. However the Loma Prieta earthquake changed that history.[1] On October 17, 1989, the Loma Prieta earthquake, the largest earthquake to hit an urban area in California since the 1906 San Francisco earthquake, struck the City of Santa Cruz. The earthquake destroyed over 50% of the downtown commercial core, displacing over 205 commercial, professional and service businesses, 5,000 employees, and hundreds of residents.[2]

While we cannot predict or protect ourselves against every possible hazard that may strike the community, we can anticipate many impacts and take steps to avoid or reduce the harm they will cause. This Local Hazard Mitigation Plan Five Year Update is part of an ongoing process to evaluate the risks that different types of hazards pose to Santa Cruz and will engage the city and the community in dialogue to identify the most important steps to pursue in order to reduce these risks.

Santa Cruz and community members have been working together during the past several years to identify and address the risks posed by earthquakes, floods, fires and other potential hazards. Many measures such as raising levees, vegetation management, a comprehensive water management plan and seismic retrofits have significantly reduced the community's vulnerability to these hazards. Over time, this focus on disaster preparation will make the city a much safer and more sustainable community.

Climate Adaptation

Following extensive public outreach and workshops the Santa Cruz completed and adopted a Climate Adaptation Plan in December, 2011, funded by CalOES' Pre-Disaster Mitigation Competitive Grant (Award #2007-1004; PDM-07 PL 02). That plan addressed the impacts our community can expect due to the continuing challenges of climate change and outlined specific adaptation strategies aimed at increasing resilience.

With new scientific data, modeling and methods available, the City is in the process of preparing the 2017 Climate Adaptation Plan Update. In 2017, the Climate Vulnerability Study was updated by city staff (non-coastal impacts) and Central Coast Wetlands Group (CCWG) was contracted to conduct the City's first Sea Level Rise Vulnerability Analysis. CCWG's three key objectives were intended to further City planning for the likely impacts associated with sea-level rise (SLR) by:

1. Identifying critical coastal infrastructure (municipal, residential and commercial) vulnerable to SLR and estimating when those risks may occur;
2. Identifying specific hazards (coastal flooding, sea level rise, erosion) that pose risks to various infrastructure, and
3. Defining appropriate strategies for these risks.

In a new and innovative piece to the Climate Adaptation Plan Update, the City partnered with the American Geophysicist's Union Thriving Earth Exchange to connect with Dr. Juliano Calil to assess social vulnerability to climate change. Dr. Calil worked with the City to compile social vulnerability scores and mapping for census blocks in the City. Key social vulnerability drivers in Santa Cruz include increased presence of crime, elderly, disabled, and low income populations, and populations for whom English is a secondary language. The social vulnerability scores, when overlain with the SLR impact hazard zones provide greater insight into appropriate adaptation strategies for those areas based on the drivers of social vulnerability in addition to geography.

Both the sea level rise and social vulnerability assessments offer greater detail on the temporal and geographic extent of expected climate change impacts, their economic impacts, and allow for greater customization of adaptation strategies in the Climate Adaptation Plan Update effort.

It is the intention of this LHMP Update to meet the requirements of the federal Disaster Mitigation Act of 2000 and to outline and demonstrate progress in planning and mitigation efforts. DMA 2000 §322 (Mitigation Planning) specifically addresses mitigation planning requirements at the state and local levels. Following approval of this updated LHMP by FEMA, and adoption by the City Council, the City of Santa Cruz will be eligible to apply for mitigation grants before disasters strike.

Mitigation Plan Objectives and Actions

Santa Cruz strives to be a disaster-resistant community that can avoid, mitigate, survive, recover from, and thrive after a disaster while maintaining its unique character and way of life. City government should be able to provide critical services in the immediate aftermath of a devastating event of any kind. The people, buildings and infrastructure of Santa Cruz should be resilient to disasters. The city's overall objective is to have basic government services and commercial functions resume quickly after a damaging earthquake or other significant event.

Mitigation Plan Primary Goals

This Plan has a number of primary goals for reducing disaster risk in Santa Cruz:

1. Avoid or reduce the potential for loss of life, injury and economic damage to Santa Cruz residents from earthquakes, wildfires, floods, drought, tsunami, coastal erosion, landslide, and dam failure.
2. Increase the ability of the city government to serve the community during and after hazard events.
3. Protect Santa Cruz' unique character, scenic beauty and values from being compromised by hazard events.
4. Encourage mitigation activities to increase the disaster resilience of institutions, private companies and systems essential to a functioning Santa Cruz.
5. Continue to monitor effects of climate change as outlined in the City of Santa Cruz Climate Adaptation Plan.

CHAPTER 1: ADOPTION BY CITY COUNCIL

Formal City Council Adoption by Resolution (LHMP 2012–2017)
June 24, 2014

RESOLUTION NO. NS-28,796

RESOLUTION OF THE CITY COUNCIL OF THE CITY OF SANTA CRUZ ADOPTING THE CITY OF SANTA CRUZ LOCAL HAZARD MITIGATION PLAN FIVE YEAR UPDATE AS APPROVED BY THE FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA)

WHEREAS, the City of Santa Cruz having developed a Local Hazard Mitigation Plan Five Year Update meeting the requirements of Section 409 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988, and Section 322 of the Disaster Mitigation Act of 2000; (DMA 2000) and

WHEREAS, the DMA 2000 requires all cities, counties, and special districts to adopt a Local Hazard Mitigation Plan, and to update that plan at least every five years as a condition of future funding for disaster mitigation from multiple FEMA pre- and post- disaster mitigation grant programs; and

WHEREAS, the City of Santa Cruz seeks to maintain and enhance both a disaster-resistant and resilient city reducing the potential loss of life, property damage, and environmental degradation from natural disasters, while accelerating economic recovery from those disasters.

NOW, THEREFORE, BE IT RESOLVED that the City of Santa Cruz does hereby adopt the City of Santa Cruz Local Hazard Mitigation Plan Five Year Update as an official plan in accordance with the federal Disaster Mitigation Act of 2000, thereby meeting the continued eligibility requirements for the potential receipt of hazard mitigation grant funds; and

Be it further resolved, that the City of Santa Cruz will submit this Adoption Resolution to Federal Emergency Management Agency Region IX Mitigation Division IX officials to enable the plan's final approval.

PASSED AND ADOPTED this 24th day of June, 2014, by the following vote:

AYES:	Councilmembers Bryant, Terrazas, Comstock, Mathews, Posner; Vice Mayor Lane; Mayor Robinson.
NOES:	None.
ABSENT:	None.
DISQUALIFIED:	None.

APPROVED: ______________________
Mayor

ATTEST: ______________________
City Clerk Administrator

Adoption

RESERVED FOR 2018–2023 LHMP COUNCIL ADOPTION RESOLUTION

CHAPTER 2: COMMUNITY PROFILE

COMMUNITY PROFILE

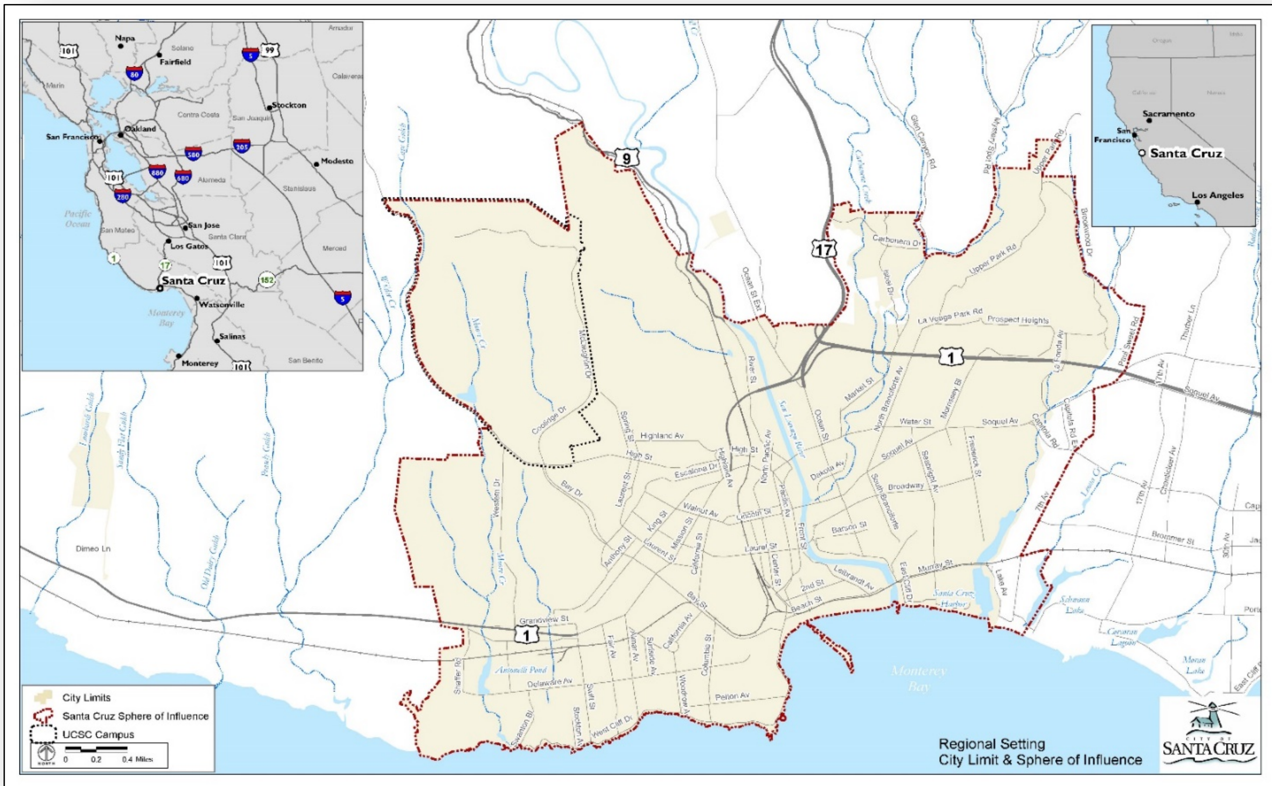


Figure 2 – City of Santa Cruz Location within the State of California

Source: City of Santa Cruz GIS, 2017

Additional sources: [UCSC Final Draft LRDP [2005–2020]]
[UCSC Academic Personnel Resources]

Santa Cruz may be a small city but we boast a lot of character and endless opportunities to enjoy the arts, connect with community, and explore the great outdoors. Flanked by the incredible redwood forests and the Monterey Bay National Marine Sanctuary, our city feels infused with nature. It’s an incredible location with many opportunities within reach.

We’re a short skip away from the San Francisco Bay Area and Silicon Valley. With easy access to major airports, sports and entertainment venues, nestled between the Santa Cruz Mountains and the Monterey Bay, our unrivalled environment creates a thriving and open culture that invites innovation, entrepreneurship, and an ethos of keeping it real.

You don’t have to be a yogi or bicycle pump track superstar to appreciate how active and healthy Santa Cruz is as a community. We support all different kinds of activities, including park infrastructure that’s accessible to everyone, so you can get out and live a full life. Beyond a plethora of activities, we sport one of the highest densities of specialty grocers per capita, along with several active farmers markets where we enjoy food and drink that support the whole health of our active community.

Santa Cruz’ mild weather, proximity to several northern California metropolitan centers, and scenic and recreation resources make it a popular day and extended-stay recreation area. As a result, the population is subject to large seasonal variations due to an influx of visitors during summer and other peak recreational periods. Planning for potential hazards in Santa Cruz must address the safety of its visitor population as well as residents, large student population, and workers within the community.

Santa Cruz is the largest city in Santa Cruz County and serves as the County government seat. Since its founding, it has been the urban center of the County, providing employment and commercial, governmental, social, educational and cultural services to the larger area. The establishment (1964) and growth of the University of California at Santa Cruz have reinforced the city's role as a major social, cultural and scientific research center.

Santa Cruz occupies a picturesque location along the banks of the San Lorenzo River, between the Pacific Ocean on the Monterey Bay and the Santa Cruz Mountains. Public and privately owned lands along the city’s western, northern and eastern boundaries form a greenbelt of open space; land uses, including agriculture and grazing lands, natural areas, parks, coastal recreation and low-density residential areas. This picturesque location also contributes to the potential hazards faced by the city. The downtown and higher density urban core is located within a flood plain. There are only four bridges across the river connecting the two sides of the community. Past experience has shown that losing even one of these bridges in a disaster presents significant problems in addition to traffic impacts.

The city’s Mediterranean climate is characterized by warm, dry summers and mild, rainy winters. Warm temperatures and low precipitation are the norm from approximately April through August. November through March is dominated by cooler temperatures and heavy rains. Though winters are typically mild, colder winds from inland regions with more continental climates can result in short-term cold snaps. During the year the average temperature is approximately 58° F. The average high temperature is 69° F and the average low temperature is 47° F. Because of this temperate climate, extreme heat is rarely a threat to the community. Both summer and winter temperatures are moderated by the marine influence and summer fog is a common occurrence. Winds are generally northwesterly and seldom reach severe intensities. The Santa Cruz Mountains form a natural barrier to winds from the north and from the hot interior valleys. Rainfall averages approximately 31 inches per year. Over the past 25 years, it has ranged from 15 inches in 1989 to 59.8 inches in 1983 with an average 32 inches of rainfall annually (UCSC 2005 Long Range Development Plan [LRDP]).

Table 2-1 Temperature Averages for Santa Cruz

Average High/Low Temperature	Average Rainfall
January 63˚/41˚F (17˚/5˚C)	January 6.3 inches (160mm)
August 76˚/54˚F (24˚/12˚C)	August 0.04 inch (1mm)

Source: U.S Climate Data

Table 2-2 City of Santa Cruz Population and Household Growth — U.S. Census 2011–2015 American Community Survey 5-Year Estimates

Population(s)	Number	Percent
Total population	62,752	100.0
Sex and Age		
Male	30,895	49.2
Female	31,857	50.8
Median age (years)	28.7	
18 years and under	8,698	13.9
65 years and over	6,079	9.7
Disabled	4,639	7.4
Total households	21,657	100.0
Households with individuals under 18 years	4,817	22.2
Households with individuals 65 years and over	4,111	19.0
Average household size	2.39	
Housing Occupancy		
Total housing units	23,499	100.0
Occupied housing units	21,516	91.6
Vacant housing units	1,983	8.4
Homeowner vacancy rate (percent)		1.8
Rental vacancy rate (percent)		2.7
Owner-occupied housing units	9,459	44
Renter-occupied housing units	12,057	56
Average household size of owner-occupied unit	2.47	
Average household size of renter-occupied unit	2.51	

The population of the City of Santa Cruz grew an estimated 4.7% between 2010 and 2015, rising from an estimated 59,946 to 62,752 persons. Approximately 13.9% of households have residents under 18 years old. Approximately 9.7% of households have residents 65 or over. Approximately

7.4% of the population has some type of disability. In creating a hazard mitigation plan it is important to consider each of these special populations. It should also be noted that the city water system serves approximately 93,000 people inside and outside the city limits. Detailed census data can be found in Appendix M: Census Characteristics.

The University of California at Santa Cruz (UCSC)

The City of Santa Cruz is home to the University of California at Santa Cruz. The main campus consists of over 2,000 acres on the northwest side of the community off High and Bay Streets. Of UCSC's 10.6-mile perimeter, 1.75 miles adjoin the city. Approximately 53 percent of the campus, including most of the developed area, is located within the Santa Cruz city limits, and the remainder of the campus lies in the unincorporated area of Santa Cruz County.[3]

In addition to the main University campus, the University also has a Coastal Science Campus located on the north side of the city situated along the coast. The University owns property at 2300 Delaware Avenue on the west side of town (used as office and research space) and leases additional space in the downtown area and on the west side of Santa Cruz. The university also leases property in the nearby city of Scotts Valley.

Much of the University infrastructure and services are at least somewhat dependent on the City. UCSC receives water and sewer treatment services from the City of Santa Cruz. Water supply has been identified as a key issue for both the City and the University. While the city water supply system is essentially the same as in 1960, the service population has increased 190% and is expected to continue to increase. In normal and wet years, the water supply system is capable of meeting the needs of the current population, but even without population increases, the system is highly vulnerable to shortages in drought years.

The City and the University are also linked through mutual aid agreements in areas such as fire services. UCSC and the City recently merged their Fire Departments. On July 2, 2014 both agencies entered into a ten-year contract for fire and EMS response services (excluding prevention).

The University has a current enrollment of approximately 17,615 students supported by approximately 8,143 (April 2016) faculty and staff (per UCSC Full-Time and Part-Time Headcount).[4]

The developed area of the UC Santa Cruz campus (existing and approved) includes 3,113,000 assignable square feet (ASF) and 4,825,000 gross square feet (GSF) in 420 separate buildings within 116 building complexes. This includes existing buildings and projects approved and funded after adoption of the 1988 LRDP.[5]

The University adopted its own Emergency Plans (Hazard Vulnerability Assessment Summary Report). It also has an Emergency Operations Plan, updated in 2016 (UCSC Emergency Operations Plan). This plan provides details about hazard response, vulnerabilities and mitigation measures for the University community.

Household Income and Education

The median household income for the City of Santa Cruz in 2015 was an estimated $62,164, compared to $67,256 for the County and $61,818 for the State. Residents of the City of Santa Cruz are highly educated, with more than 51 percent of residents over age 25 having achieved a bachelor's degree or higher by 2015.

Residents' Place of Work

In addressing potential hazard, it is important to note that much of the workforce in the County of Santa Cruz is highly mobile and integrated into two separate economic ecosystems, the high technology and research and development cluster in Silicon Valley and the academic, hospitality and agricultural clusters of the greater Monterey Bay.

According to the 2014 Census "On the Map" tool (OnTheMap) there are 94,964 persons employed in the County, of which, 59,395 work and live within the County. There are 35,569 who work in the area but live outside of the area, while some 7,410 (7.8%) drive "over the hill" to Silicon Valley and Santa Clara County daily. Another 7,873 (8.3%) travel south to Monterey County. Alameda (2.3%), and San Benito (1.7%) Counties round out the top five.

Inflow/Outflow Job Counts (All Jobs)	2014	
Employed in the Selection Area	94,964	100.0%
Employed in the Selection Area but Living Outside	35,569	37.5%
Employed and Living in the Selection Area	59,395	62.5%
Living in the Selection Area	111,396	100.0%
Living in the Selection Area but Employed Outside	52,001	46.7%
Living and Employed in the Selection Area	59,395	53.3%

The City of Santa Cruz' total labor force (population 16 years or older) was estimated as 33,500 in February 2017 with an employed population of 30,900 and unemployed of 2,500. The average commute time for employed residents of the City of Santa Cruz was 22.3 minutes in 2015, indicating that most of the residents of the city are employed within the city.

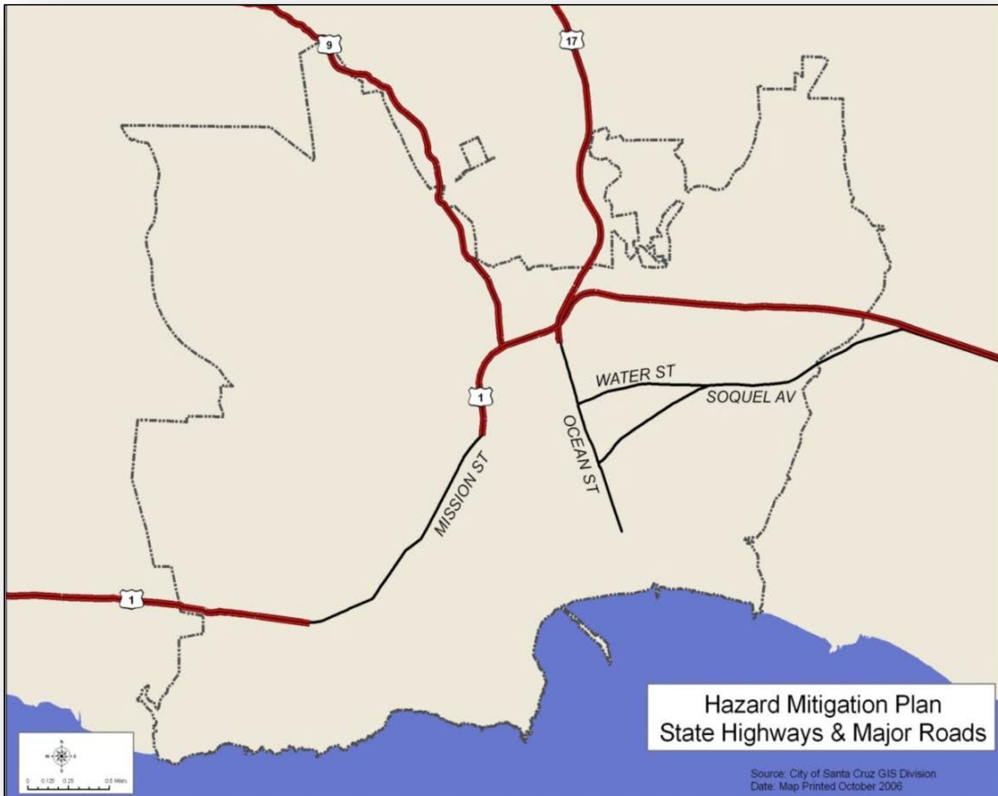


Figure 3 – Key Transportation Routes to and within Santa Cruz *Source*: City of Santa Cruz GIS, 2017

Santa Cruz is a compact urban community with only three major access routes into and out of town; Highway 1 (north and south) and Highway 17 (east.) Major transportation routes include Mission Street (which is also Highway 1), Bay Street, Ocean Street, Water Street, and Soquel Avenue. Primary roadways in the downtown and beach area include Pacific Avenue, Front Street, Beach Street and East and West Cliff Drive.

The Santa Cruz Metropolitan Transit District (Metro) provides bus service throughout Santa Cruz County. The Metro is a key link from the University to the other parts of the town. Metro also operates bus service between the City of Santa Cruz and San Jose. Access to and from the University is particularly vulnerable at present since there are only two streets, Bay and High which access campus. Both these streets intersect with Mission Street and according to the UCSC Long Range Development Plan Environmental Impact Report (EIR) there are unacceptable traffic service levels at several of these intersections.[4]

Santa Cruz has an extensive network of bike lanes and bike paths. Additionally, on February 28, 2017 the City Council adopted an Active Transportation Plan (ATP) that, "identifies an integrated network of walkways and bikeways that connect the City of Santa Cruz neighborhoods and communities to employment, recreation, education and destinations that meet their daily needs." The ATP will reduce traffic and increase the resilience of our transportation systems.

Most major roads have bike lanes, including bike lanes that were recently installed on Beach Street near the Santa Cruz Beach Boardwalk, the city's major tourist attraction. There are levee bike paths along the San Lorenzo River developed as part of the San Lorenzo River Levee Project, a sixty-two million dollar project which was undertaken to address flooding in the city. Additionally, the city will begin construction of the 2 mile segment of the 32 mile coastal rail corridor from Watsonville to Davenport that passes through the City of Santa Cruz. The segment will be a paved, 12–16 foot wide multi-use path running from Natural Bridges Drive to Pacific Avenue near the Municipal Wharf in 2017.

Economic Trends and Retail Sales

American Fact Finder Community Facts

2011-2013 American Community Survey 3-Year Estimates				
Subject	**Est.**	**Est. Margin of Error**	**%**	**% Margin of Error**
Civilian employed population 16 years and over	31,203	+/-1,221	57.7	(X)
Occupations				
Management, business, science, and arts	13,971	+/-1,010	44.8	+/-2.8
Service	6,292	+/-798	20.2	+/-2.5
Sales and office	7,189	+/-880	23.0	+/-2.4
Natural resources, construction, and maintenance	2,075	+/-432	6.7	+/-1.4
Production, transportation, and material moving	1,676	+/-522	5.4	+/-1.7

Industry	**Est.**	**Est. Margin of Error**	**%**	**% Margin of Error**
Civilian employed population 16 years and over	31,203	+/-1,221		(X)
Agriculture, forestry, fishing and hunting, mining	448	+/-279	1.4	+/-0.9
Construction	1,595	+/-351	5.1	+/-1.2
Manufacturing	2,176	+/-424	7.0	+/-1.3
Wholesale trade	663	+/-255	2.1	+/-0.8
Retail trade	3,910	+/-864	12.5	+/-2.6
Transportation, warehousing, utilities	578	+/-211	1.9	+/-0.7
Information	579	+/-188	1.9	+/-0.6
Finance, insurance, real estate, rental, leasing	1,555	+/-435	5.0	+/-1.4
Professional, scientific, management, administrative, waste management services	3,806	+/-613	12.2	+/-2.0
Educational services, health care, social assistance	8,504	+/-756	27.3	+/-2.6
Arts, entertainment, recreation, accommodation, food services	4,929	+/-925	15.8	+/-2.8
Other services, except public administration	1,479	+/-531	4.7	+/-1.7
Public administration	981	+/-334	3.1	+/-1.1

Of a total citywide employment base of 31,203, management, business, science and arts occupations were the most represented in the 2013 census data at 13,971. The service industry, including hotels and restaurants was the second place categorization, with sales, and construction in third and fourth respectively. Public sector administration accounts for 3.1% of the total workforce, while educational services, health care and social assistance represents 27.3% of the workforce employment.

Education represents a substantial contributor to the local economy, due to both the area's K–12 schools and UCSC. A list of public and private schools in the community are included in this plan as Appendices E–F.

Income and Benefits (in 2013 Inflation-Adjusted Dollars)				
Subject	**Est.**	**Est. Margin of Error**	**%**	**% Margin of Error**
Total households	21,154	+/-805		(X)
Less than $10,000	2,301	+/-504	10.9	+/-2.2
$10,000 to $14,999	1,129	+/-347	5.3	+/-1.6
$15,000 to $24,999	1,726	+/-394	8.2	+/-1.8
$25,000 to $34,999	1,715	+/-393	8.1	+/-1.8
$35,000 to $49,999	2,072	+/-385	9.8	+/-1.8
$50,000 to $74,999	3,683	+/-562	17.4	+/-2.7
$75,000 to $99,999	2,246	+/-355	10.6	+/-1.7
$100,000 to $149,999	3,060	+/-469	14.5	+/-2.1
$150,000 to $199,999	1,408	+/-369	6.7	+/-1.7
$200,000 or more	1,814	+/-264	8.6	+/-1.3
Median household income (dollars)	**62,580**	**+/-4,220**	(X)	(X)
Mean household income (dollars)	**83,037**	**+/-4,404**	(X)	(X)

Median household income is $62,580 while mean household income is $83,037. Just over 8% of homes report income of $200,000 or more, while households that earn between $15–24,000 a year account for 8.2% of the population, $35–49,000 households account for 9.8% and households between $50–75,000 represent 17.4% of all homes in Santa Cruz.

Like all California communities, a significant portion of Santa Cruz' General Fund and much of its downtown economy is derived from retail sales. Since the downtown and beach areas provide a large proportion of the city's economic prosperity, potential hazards in these areas make the city particularly vulnerable to economic loss in addition to physical loss. These areas are identified as being within the potential flood area, liquefaction area and tsunami risk area.

Community Vision

The City of Santa Cruz updated its General Plan (2012) including the Safety Element, which promotes public health and safety through goals, objectives and action plans addressing potential hazards such as earthquake, flood, and wildfire. The Safety Element provides a general evaluation of potential public safety hazards and also provides the direction and resources to help reduce death, injuries, property and environmental damage, and the economic and social dislocation resulting from natural hazards. The General Plan Update has informed this LHMP and this Plan has in turn informed the current update of the General Plan. Working collaboratively, both plans support the broader vision and values of the community as reflected in the vision statement for the General Plan update.

General Plan Vision Statement

Our Vision for Santa Cruz, 2030

Surrounded by greenbelt and the Pacific Ocean, Santa Cruz is a compact, vibrant city that preserves the diversity and quality of its natural and built environments, creates a satisfying quality of life for its diverse population and workers, and attracts visitors from around the world.

Guiding Principles

To achieve our vision, we will follow these principles in drafting our General Plan.

- **Natural resources**
  We will highlight and protect our unique setting, our natural and established open space, and the sustainable use of our precious natural resources.
- **Neighborhood integrity and housing**
  We will maintain the identity and vitality of our neighborhoods, actively pursuing affordable housing for a diversity of households and promoting compatible livability and high quality design in new buildings, major additions, and redevelopment.
- **The University**
  We will seek a mutually beneficial relationship with UC Santa Cruz, one where the City supports the University within the context of City responsibilities, community priorities, and the constraints of City infrastructure and resources; and one where the University reciprocally supports the City by comprehensively addressing all of its needs to the greatest extent possible on the campus itself, and by fully mitigating whatever off-campus community impacts occur.
- **Mobility**
  We will provide an accessible, comprehensive, and effective transportation system that integrates automobile use with sustainable and innovative transportation options — including enhanced public transit, bicycle, and pedestrian networks throughout the community.
- **Prosperity for all**
  We will ensure a sustainable economy for the community, actively encouraging the development of employment opportunities for residents of all levels and ages, and actively protecting from elimination our current and potential sources of sustainable employment.
- **A dependable municipal tax base**
  We will encourage diverse technology, visitor serving, industrial, home business and commercial business enterprises, and strategic redevelopment.
- **A balanced community**
  We will maintain the community's longstanding commitment to shared social and environmental responsibility, fostering a balance between employment, housing affordable to persons of all income levels, transportation, and natural resources.

- **Education**
  We will reflect our commitment to education through our schools, educational systems and programs, library system and facilities, life-long learning community programs, and our active communication/information network.
- **Arts and culture**
  We will recognize and support our vital arts community, our unique historic areas and landmarks, our cultural heritage and resources, and our recreational facilities and community programs
- **Community facilities and service.**
  We will offer excellent social services and will improve and maintain our infrastructure, community safety, and emergency preparedness.
- **An involved citizenry**
  We will welcome citizen participation in government, encourage respectful cooperation and mutual regard among residents, workers, students, and visitors, and fully accept shared responsibility for community well-being.

General Plan 2030 Adopted June 26, 2012

Critical Structures within the City of Santa Cruz and Unincorporated Surrounding Area

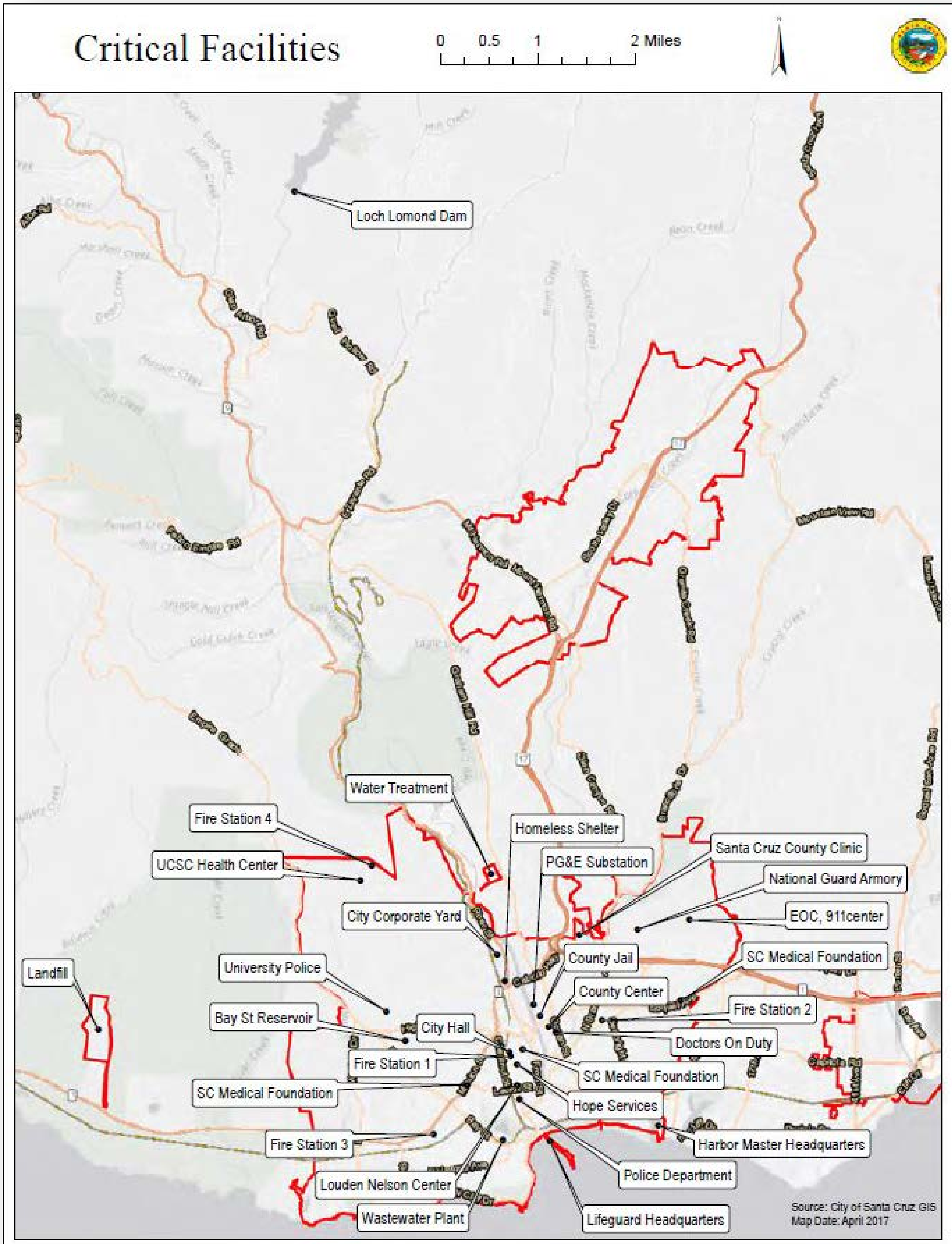


Figure 4 – Critical Structures within the City of Santa Cruz and Unincorporated Surrounding Area

Source: City of Santa Cruz GIS, 2017

COMMUNITY FACILITIES

The City of Santa Cruz owns or leases approximately forty significant buildings. These buildings are used for various purposes including government administration, providing essential and emergency services, recreation, cultural and performing arts. After the 1989 Loma Prieta earthquake, the city began examining the risks to its buildings from disasters, particularly earthquakes. A number of buildings were assessed for seismic safety and, when warranted, strengthened. Some city buildings essential for emergency response activities have been assessed and repaired or replaced.

A list of City facilities appears in Appendix I. Appendix N shows the larger Santa Cruz County area including Loch Lomond Reservoir from which Figure 4 (*above*) is extracted.

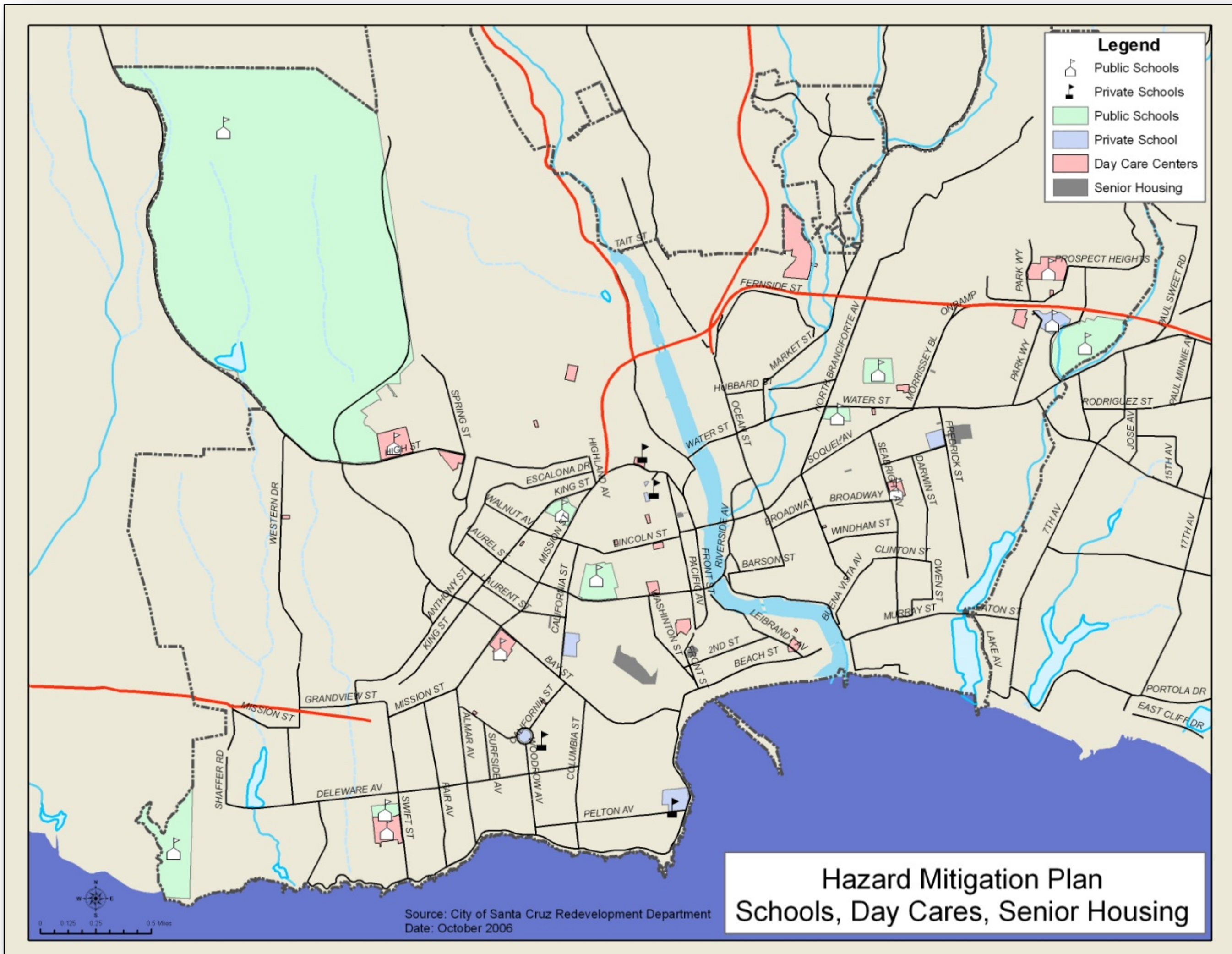
City of Santa Cruz-owned infrastructure consists of the following elements:

Water Treatment Plant
Loch Lomond Reservoir
River levees
Roads, alleys, curbs, paths
Retaining walls
Storm drains
San Lorenzo River, creeks, open channels and culverts
Wastewater Treatment Facility and sanitary sewer system
Water Street Bridge
Soquel Bridge
Laurel Street Bridge
Highway 1 Bridge (two sections)
Over 25 City parks and extensive network of street trees
Municipal Wharf including Marine Safety and Lifeguard Headquarters
Emergency Operations Center*
**leased: primary EOC site*

Critical Facilities not owned by the City

There are a number of critical facilities within the city limits that are not owned by the City. The County Government Center, the County Jail, the National Guard Armory and the U.S. Post Office are some of the buildings that are within the city but are not owned by the City. The primary Emergency Operations Center is a leased facility.

Hospitals and schools are critical facilities that are not operated or owned by city government.



Hospitals

There are no hospitals within the City of Santa Cruz. There are several rehabilitation facilities, medical clinics, senior and long term care facilities.

Figure 5 – Public and Private Schools, Day Care and Senior Facilities *Source*: City of Santa Cruz GIS, 2017

Schools

Santa Cruz City Schools is independent from City government and manages primary and secondary education and education facilities, including all public schools in the city. The City government has no authority over these structures, but does provide police and fire services to the school district.

PART 2 — THE PLANNING PROCESS

- The Purpose of the Plan
- The Planning Process
- Documentation of the Planning Process
- Local Capabilities Assessment and Integration
- Community Participation

CHAPTER 3: THE PLANNING PROCESS

THE PURPOSE OF THE PLAN

The federal Disaster Mitigation Act of 2000 (Public Law 106-390), commonly known as the 2000 Stafford Act Amendments, was approved by Congress on October 10, 2000. To implement the DMA 2000 planning requirements, FEMA prepared an Interim Final Rule, published in the Federal Register on February 26, 2002 (44 CFR Part 201) which established mitigation planning and funding criteria for states and local communities. This act required state and local governments to develop hazard mitigation plans as a condition for federal grant assistance.

For the Pre-Disaster Mitigation (PDM) program, local jurisdictions must have an approved mitigation plan to receive a project grant. Prior to 2000, federal legislation provided funding for disaster relief, recovery, and some hazard mitigation planning. The DMA improves upon the planning process by emphasizing the importance of community planning for disasters before they occur. Using this initiative as a foundation for proactive planning, the City of Santa Cruz developed this hazard mitigation plan in an effort to reduce future loss of life, property and damage to our environment resulting from disasters. This LHMP Update continues that effort.

Hazards are difficult to predict. Through careful planning and collaboration among public agencies, stakeholders, and citizens, it is possible to avoid or minimize losses that can occur from disasters. Hazard mitigation is defined as any action taken to permanently eliminate or reduce long-term risks to human life and property from natural hazards. Along with preparedness, response, and recovery, mitigation is an essential element in emergency management. Disasters can have significant impacts on communities. They can destroy or damage life, property, infrastructure, local economies, and the environment.

This LHMP Update is intended to assist the City of Santa Cruz in reducing its risk from natural hazards by identifying resources, information, and strategies for risk reduction. The plan will help guide and coordinate mitigation activities throughout the city. Building on a tradition of progressive planning and past mitigation successes, the City of Santa Cruz planning team set out to develop a plan that would meet the objectives summarized below.

- The plan would meet or exceed program requirements specified under the DMA.
- The plan would not only meet state and federal requirements but also the needs of the City.
- The plan would coordinate existing and ongoing plans and programs so that high priority initiatives and projects to mitigate possible disaster impacts would be funded and implemented.
- The plan would create a linkage between the LHMP and established plans such as the City's General Plan, Climate Adaptation Plan and Emergency Operations Plan so that they can work together in achieving successful mitigation for the City.

It should be noted that DMA compliance is not the sole purpose of this LHMP. Santa Cruz has experienced a number of significant disasters but it also has a long-standing tradition of proactive planning and program implementation. This tradition is further enhanced by the development of this LHMP. Multiple objectives drive this planning effort, one of which is DMA compliance. Elements and strategies included in this plan were not selected only because they meet a program requirement; they were selected because they meet the needs of the community.

Planning Process

This section describes the process used to develop the LHMP. This includes the federal requirement followed by the City's actions applied to this process.

Documentation of the Planning Process

2.1 Documentation of the Planning Process — Requirement §201.6(b):
In order to develop a more comprehensive approach to reducing the effects of natural disasters, the planning process **shall** include:

(1) An opportunity for the public to comment on the plan during the drafting stage and prior to plan approval;
(2) An opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academia and other private and non-profit interests to be involved in the planning process; and
(3) Review and incorporation, if appropriate, of existing plans, studies, reports, and technical information.

Requirement §201.6(c)(1):
The plan **shall** document the planning process used to develop the plan, including how it was prepared, who was involved in the process, and how the public was involved.

Project Teams: Then and Now

The City of Santa Cruz developed and adopted its first Local Hazard Mitigation Plan in 2007. The current plan is an update to our first Five Year LHMP (2012–2017). The following information outlines the team and process that was involved in the initial LHMP:

LHMP (2007–2012)

The Economic Development Department took on the initial responsibility for development of the 2007 LHMP. The first phase of the planning process established a project team made up of representatives from various City departments, especially those responsible for different aspects of hazard mitigation planning, including the Economic Development Department, Planning Department and its Building Division, Public Works, Emergency Operations Manager, Fire, and Information Technology's Geographic Information Systems (GIS) specialist.

The original project team was formed as a task group to develop the LHMP. Meeting dates were set intermittently based on progress and focus. The Project Team invited review of the plan at various stages of formation and completion from interested parties such as the University of California at Santa Cruz, Santa Cruz County, the Cities of Capitola, Watsonville and Scotts Valley, the County Office of Emergency Services, the local American Red Cross as well as scientific and technical specialists at the local, state, and national level.

The original plan was developed between June 2006 and March 2007. Project leaders met once per week and the team met approximately once per month from June 2006 through December 2006, and then as needed in 2007 until the draft plan was circulated for public review in April.

The project team list as well as the Technical Advisors list (Part 1: Acknowledgements), has been updated to reflect the team for the current LHMP (2018–2023).

LHMP Five Year Update (2018–2023)

The project team identified characteristics and potential consequences of natural hazards that are a potential threat to the City of Santa Cruz. With the understanding of the risks posed by the identified hazards, the team determined and reviewed previously listed priorities and assessed various methods to avoid or minimize any undesired effects. Recent historical incidents were noted and assessed. Responsible departments were consulted at several points in the development of the goals, objectives and actions. As a result, the mitigation strategy, including goals, objectives and actions, were determined, followed by an implementation and monitoring plan. This monitoring plan included tracking of hazard mitigation projects, changes in day-to-day City operations, and continued hazard mitigation development.

Local Capabilities Assessment and Integration

This assessment of the mitigation goals, programs and capabilities included a review of the following items:

- Human and technical resources
- Financial resources and funding sources
- Local ordinances, zoning and building codes
- Ongoing plans or projects

The 2007 LHMP and the 2012 Five Year LHMP Update were informed by the General Plan Safety Element, Emergency Operations Plan, Urban Water Management Plan, Santa Cruz Water

Department Water Conservation Plan, City ordinances, zoning and building codes and the Capital Improvement Program (CIP). This information was also used for the current LHMP Update (2018–2023).

Consistency between these plans, programs and policies was reviewed by using these approved plans and policies as a foundation for the 2007–2012 LHMP and by consulting with the departments responsible for the various plans and programs. In reviewing the effectiveness of local programs, Appendix K lists successful programs and projects that have been implemented by the City. Appendix O is the City's Emergency Operations Plan (EOP). While these programs and the EOP have increased the City's hazard mitigation capabilities, funding availability is the limiting factor in the implementation of additional identified hazard mitigation programs.

The 2007–2012 LHMP Project Team met several times with the staff and members of the General Plan Advisory Committee to insure that the LHMP was consistent with the General Plan Safety Element. Project leaders met with representatives of the Water Department to incorporate hazard mitigation efforts identified by various Water Department plans. Project leaders met with Fire Department staff to insure that the LHMP was consistent with the current and planned programs and fire safety plans. The project leaders also met with the City's GIS coordinator to ensure that maps were current and consistent with those in the General Plan and were accurate as of the draft publication date.

The City of Santa Cruz Emergency Operations Center (EOC) Manager was a member of the Project Team and oversaw the review and incorporation of the Emergency Operations Plan and its appendices:

- County Standardized Emergency Management System (SEMS), Memorandum of Understanding (MOU) Resolution
    - This MOU is an appendix to the City of Santa Cruz Emergency Operations Plan. The EOP states: "The City of Santa Cruz plans for, and responds to, emergency events in accordance with the Santa Cruz County Operational Area Memorandum of Understanding (MOU). This MOU ratifies local government agreements to follow the SEMS as mandated under California law.it." Insofar as this is a response/recovery protocol and not a mitigation planning mechanism, its relationship to the LHMP is limited.
- City of Santa Cruz Hazard Analysis Summary (EOP)
    - This summary (under revision and construction as of this writing) will directly reflect the hazard analysis derived from the LHMP.
- Wharf Hazard Plan
    - It is anticipated that future iterations of the Wharf Hazard Plan will be reviewed in light of the climate adaptation and mitigation action items found in the LHMP as well as the Coastal Storm hazard analysis in the LHMP.

From *AB 691 Sea-Level Rise Assessment City of Santa Cruz Tide and Submerged Lands 1969 Grant*

<u>Santa Cruz Municipal Wharf</u>

The Santa Cruz Wharf Engineering Report, 2014 contains a complete analysis of the potential impacts of storms and extreme events on the structure of the Santa Cruz Municipal Wharf. It also includes a section on Monterey Bay tidal action and how more extreme storm events will increase the impact of the normal tidal actions.

This description of the proposed mitigation/adaption measures is outlined …in the Wharf Mater Plan, page 13, as follows:

> "2. Strengthen the Wharf and increase its resiliency to extreme weather conditions, seismic events and sea level rise.
>
> - Continue the regular maintenance and on-going replacement of piles, bents, stringers, and decking to enhance the condition and longevity of the Wharf Provide for the continuity of stringers and caps and additional bolts or side plates at unsupported cap splice locations.
> - Increase the number of vertical piles in the transverse direction (width of the Wharf) in conjunction with public improvements that benefit public access, recreational activities and boating to increase the Wharf's strength to resist forces imposed by storm waves and earthquakes.
> - Provide outriggers in the deeper water area between Bents 170 and 179 connected to the existing horizontal ledgers to most effectively enhance the rigidity and reduce the sway of the Wharf in extreme weather conditions or during a seismic even.
> - Limit truck traffic to the greatest extent possible to minimize damage to the paving and substrate of the Wharf."

- Hazard Analyses

  All of the Hazard Plans mentioned below are annexed to the City Emergency Operations Plan, which itself is appended to the LHMP, and their content (under revision and construction as of this writing), are/will be, directly reflective of the LHMP hazard analyses. Each of these items has a dedicated Chapter in the LHMP

- Flood Hazard Plan
- Earthquake Hazard Plan

- Dam Inundation Hazard Plan
- Wildland Fire Hazard Plan
- Tsunami Hazard Plan

COMMUNITY PARTICIPATION

2018–2023

For this current LHMP Update the project manager promulgated a public survey in March 2017. The survey, entitled "*Are You Ready*? *Local Hazard Mitigation Public Survey* (detailed in Chapter 15: Public Outreach and Plan Development) was posted to the City of Santa Cruz website home page and on other public-facing social media pages. Additionally, the availability of the survey was called out in the city's daily newspaper of record. A local group, Santa Cruz Neighbors, which has numerous chapters and affiliations throughout the city, agreed to review the survey questions and post its availability to it members, thereby furthering the public outreach across many city neighborhoods. Additionally, a Spanish language version of the survey was made available.

Furthering the goal of expansive public outreach, the following events were opportunities completed/scheduled (at the time of this writing) by the team working to update the LHMP and Climate Adaptation Plan (Appendix P).

Public Events Planned and Scheduled

- Panel discussant at St. Francis High School's Ecology Symposium 3/25/2017
- Radio interview on Planet Watch KSCO 4/2/2017
- Earth Day tabling at San Lorenzo Park... 4/22/2017
- "City Hall to You" tabling at Peace Church.. 5/4/2017
- Presentation to County of Santa Cruz Emergency Management Council 5/4/2017
- Information/presentation to Transportation and Public Works Commission..... 5/15/2017
- Guest Lecture to UCSC global climate politics course 6/1/2017
- Information/presentation to Transportation and Public Works Commission..... 7/17/2017
- City Council Presentation 8/8/2017
- Information/presentation to City Planning Commission 9/7/2017
- Information/presentation to Downtown Commission...................................... 9/28/2017
- "Science on Tap" feature presentation at Crepe Place (planned)................... 10/25/2017

Our local stakeholders and emergency managers will also have had the opportunity to review and comment on this plan. Their professional input has been an invaluable resource. The same process was followed for the original LHMP and its first Five Year Update.

2007–2012 and **2012–2017**

Public input during the development of the 2007–2012 mitigation plan assisted in helping shape the plan's goals and mitigation actions, and integrating the LHMP with the Safety Element of the General Plan Update. The Local Hazard Mitigation Plan was a topic of discussion at two public meetings of the General Plan Advisory Committee (GPAC).

When the draft LHMP was completed, a 30-day public comment period was initiated. A public notice was placed in the local paper to invite public review and comment on the draft plan. Copies of the plan were made available at the Central Branch of the Santa Cruz Public Library and at the Economic Development Department at City Hall. A draft of the plan was posted on the City's website with an interactive response option that provided an opportunity for interested members of the public to comment on the draft LHMP via the web. Those comments were incorporated into the final document. The LHMP was presented to the City Council on April 24, 2007. That meeting was open to the public for further comment.

The draft 2007 LHMP was sent to members of a technical committee which consisted of national, state and local scientists and experts for review prior to creation of the Public Draft. Comments received were incorporated into the final draft LHMP.

Table 3-1 LHMP Meetings

NOTE: During the development of the LHMP and Climate Adaptation Plan numerous informal meetings and other communications were underway among staff and other jurisdictional partners. These are not listed as formal meetings in the table below.

LHMP Meetings [2017]	Date	Type
Consultation re: Vulnerability Assessment	Jan 17, 2017	In house. Initial discussion with Central Coast Wetlands regarding assumptions (i.e., coastal hazards) going forward on the Vulnerability Assessment as the LHMP project got underway; including the Climate Adaptation Plan that is appended to, and a key component of, the LHMP (Appendix P).
City Kickoff Meeting	Feb 1, 2017	In house: Consultant selected; attorney review of contracts (See Agenda) In part – Update on American Geophysical Union Work/Schedule • Quantification of non-coastal climate impacts • Engineering design criteria for long-term policy changes/infrastructure investments
Central Coast Wetlands Group	Feb 20, 2017	In house: Review consultant scope
Confirm Climate Adaptation	Feb 28, 2017	In house: Assessing non-coastal impacts
Map layer and data consultation	Feb 28, 2017	In house
Consultant Kickoff	Mar 1, 2017	In house: With full LHMP group
Vulnerability Assessment	Mar 7, 2017	In house: Model assumptions reviewed by City staff including GIS and Project Leads and scientific vulnerability assessment team members
CCWG/Team meeting with Public Works	Mar 21, 2017	In house: Review (1) coastal armoring inventory; discuss water control structures; (2) progress of LHMP and Climate Adaptation Plans
LHMP and Climate Adaptation Team Leaders	Apr 5, 2017	In house: Timeline review; coordinate CAP with LHMP; next steps Some items of particular focus: • Socially vulnerable populations relevant to hazard mapping • Mitigation strategy discussion
LHMP Project Manager	Apr 18, 2017	Online conference — “Flood Plain Management, Hazard Mitigation, Emergency Management.” California Ocean Protection Council; California Natural Resources Agency; Governor’s Office of Planning and Research; California Energy Commission; and California Ocean Science Trust

LHMP Meetings [2017]	**Date**	**Type**
LHMP Project Manager, OES/Analyst	Apr 27, 2017	Review multiple Chapters and Appendices; Schedule outreach to County Emergency Management Council
LHMP Project Manager	May 4, 2017	Presentation to Emergency Management Council The Agenda for this meeting is in Chapter 15 labeled as follows: County of Santa Cruz Emergency Management Council Agenda — Presentation requesting peer and emergency managers' review of LHMP May 4, 2017 See Item 9.3.2 Present LHMP to County EMC and request peer review from surrounding jurisdictions and emergency management partners.
Climate Adaptation	May 31, 2017	In house: Discussion of progress and future peer review and presentations.
LHMP Project Manager, OES/Analyst	Sept 6, 2017	In house: Review and discuss LHMP progress at the near completion of the project

PART 3 — HAZARD IDENTIFICATION AND RISK ASSESSMENT

Significant Risks

- Earthquakes and Liquefaction
- Wildfires
- Floods and Associated Coastal Storms
- Drought
- Tsunami
- Coastal Erosion

Less Significant Risks

- Dam Failure
- Landslide

Multi-Hazard Summary

Identification and Profiling of Hazards

Risk Assessment of Hazards in Santa Cruz

3.0 Risk Assessment: §201.6(c)(2):

The plan **shall** include a risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards.

Local risk assessments **must** provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards.

It is important for a community's risk assessment, mitigation and preparedness efforts to be founded on accurate information about the types and scale of damage that hazards pose to the community. This section of the Plan contains a description of those hazards identified as potential significant threats to Santa Cruz — earthquakes, wildfires, floods, drought, tsunami, coastal erosion, landslide — and the exposure and vulnerability of the City to these hazards. These risks have been identified based on historical information of hazard events including researching past disaster declarations in the City, input from geologic, climatic, and wildfire specialists and organizations as well as public comments and newspaper articles. Probable damage and the consequences to the city's quality of life are described. One area to note in particular is the section on tsunami as it relates to the March 2011 earthquake near Honshu, Japan and its impact on our area.

The City of Santa Cruz has expanded its GIS database, mapping critical facilities, hazard risk areas, and sensitive habitat areas. Data from this mapping was used to determine hazards that present the greatest risk to the city.

Table A-1 Review of All Hazards

Hazard	Risk	Why/Why not
Avalanche	No	The City is not in an avalanche area
Coastal Erosion	Major	Past history indicates probability is high, potential for loss of life is low — potential for economic and infrastructure loss is high
Coastal Storm	—	Included with Flood
Dam Failure	Lesser	Past history indicates probability is low but consequence of failure is high
Drought	Major	Past history indicates probability is high
Earthquake	Major	Past history indicates probability is high
Expansive Soils	No	Does not affect City
Extreme Heat	No	Past history indicates probability is low
Flood	Major	Past history indicates probability is high
Hailstorm	No	Past history indicates probability is low
Hurricane	No	Past history indicates probability is low
Land Subsidence	No	Past history indicates probability is low
Landslide	Lesser	Past history indicates risk to water system is high
Liquefaction	—	Included with Earthquake
Winter Storm	No	Past history indicates probability is low
Tornado	No	Past history indicates probability is low
Tsunami	Major	Recorded history (200 years) indicates probability of a significant tsunami occurring is low but in the event that it should occur potential for life, property, economic and infrastructure loss is high
Volcano	No	Does not affect City
Wildfire	Major	The City is adjacent to many natural open space and urban /rural interface areas

3.1 Identifying Hazards - §201.6(c)(2)(i):

The risk assessment **shall** include a description of the type, location, and extent of all natural hazards that can affect the jurisdiction.

The plan **shall** include information on previous occurrences of hazard events and on the probability of future hazard events.

Table A-2 Hazard Screening for City of Santa Cruz

Risk	Affected Areas
VERY SIGNIFICANT RISK	
Earthquake (including liquefaction)	Entire city
Wildfire	Five identified wildland interface areas
Flood (including coastal storms)	San Lorenzo River floodplain including downtown and Tannery Arts Center; sections of Moore, Branciforte and Carbonera Creeks, and lower portion of Arana Gulch
Drought	Entire city
Tsunami	San Lorenzo River floodplain including beach area and downtown
Coastal Erosion	Coastal boundaries
LESSER RISK	
Dam Failure	Loch Lomond Reservoir and water delivery system and the inundation area of the reservoir
Landslide	Loch Lomond Reservoir and water delivery system. Other unstable slopes present risk to roadways.

The City of Santa Cruz is exposed to a number of natural hazards that vary in their potential intensity and impact on the City. This mitigation plan addresses six high-risk natural hazards, selected because of the likelihood of occurrence or the potential consequences, as well as two additional hazards that present either less risk of occurrence or extent of damage. The natural hazards: floods, earthquake, and tsunami are of great concern because they can occur independently, or in combinations that can trigger secondary hazards such as dam failure. Another high risk hazard, drought, can exacerbate the potential for wildfires.

The natural hazards included in this plan were identified through a community-based process including input from scientific experts in various fields and in conjunction with the update of the General Plan including the Safety Element. Prior versions of the Local Hazard Mitigation Plan were the result of a number of public meetings, project team meetings, scientific expert and community input as well as suggestions submitted by community members of Santa Cruz. Key contributors included members of the Project Team, the General Plan Advisory Committee, Dr. Gary Griggs of University of California at Santa Cruz, David Saroka of National Oceanic and Atmospheric Administration (NOAA), the Association of Monterey Bay Area Governments (AMBAG), as well as many others who worked with the City on programs and research that were incorporated into the Emergency Operations Plan and General Plan Safety Element. Other natural hazards that are extremely rare or nonexistent in Santa Cruz are not included in this plan but are listed in Appendix A.

The worst potential disaster that Santa Cruz might face involves multiple hazards occurring at the same time. A major earthquake could trigger tsunamis, wildfires or floods which would be exacerbated by damage to dams, stream culverts and storm drains. The City's emergency teams and those assigned to the Emergency Operations Center and Department Operations Center(s) have trained and practiced responding to similar, challenging, multi-hazard events. The City of Santa Cruz plans for and responds to emergency events in accordance with the Santa Cruz County Operational Area Memorandum of Understanding (MOU). The Emergency Operations Plan describes the role and operation of the City departments and personnel during a major emergency (Appendix O). In addition to researching each hazard individually, this Plan explores how the hazards interact, and how mitigation activities for each hazard impact the overall disaster risk in Santa Cruz.

Resources Used	**Explanation**
City of Santa Cruz 2030 General Plan Chapter 8: Hazards, Safety, and Noise General Plan 2030 Safety Element	"To facilitate well-coordinated and expedient action during an emergency, the City adopted an Emergency Operations Plan describing the role and operation of City departments and personnel during major emergencies from floods, storms, earthquakes, tsunamis, hazardous materials incidents, and other disasters. The City has also identified "critical facilities," major transportation routes, and utilities that may be affected in a disaster, and has devised strategies to protect them against damage and assure their usability. "(emphasis added) Pages 91– 94; 96–97 **General Plan 2030 Safety Element** Including Goals, Policies and Actions relevant to Natural Hazards Page 102–107 • FEMA Flood Zone Map • Additional Natural Hazard Maps included (City of Santa Cruz GIS)
FEMA and other Resources Used	See Chapter 6: Section 6.3.2 PROFILING FLOOD HAZARD EVENTS Section A: Location —Flood Insurance Rate Maps (FIRM) Section B: Extent: Magnitude or Severity (CRS discussion; Special Flood Hazard Area [SFHA] discussion)

Resources Used	Explanation
Climate Adaptation Planning and Plan	Appendix P is the Climate Adaptation Plan and it includes the latest scientific assessments of the vulnerabilities and hazards faced by the City of Santa Cruz due to climate change impacts and expected impacts out to the year 2030. The Climate Adaptation Plan details mitigation strategies relevant to climate impacts, the public outreach efforts used in developing the CAP, and an innovative approach to mapping vulnerable communities (age, language, disability) overlaid onto maps of hazard areas.

CHAPTER 4: EARTHQUAKES AND LIQUEFACTION

4.3.0 Risk Assessment

4.3.1 Identifying Earthquake Hazards

3.1 Identifying Hazards — Requirement §201.6(c)(2)(i):

The risk assessment **shall** include a description of the type, location, and extent of all natural hazards that can affect the jurisdiction.

The plan **shall** include information on previous occurrences of hazard events and on the probability of future hazard events.

An earthquake is a sudden release of built-up tension in the earth's crust and upper mantle, i.e., lithosphere. Caused by movement along fault lines, earthquakes vary in size and severity. The *focus* of an earthquake is found at the first point of movement along the fault line, and the *epicenter* is the corresponding point above the focus at the earth's surface.

Earthquake intensity is measured in various ways, the most familiar being the Richter *magnitude* scale which determines the amount of ground displacement or shaking that occurs near the epicenter; the Rossi-Forel scale which measures ground shaking intensity in terms of perception and damage; and the Modified Mercalli Intensity Scale which takes into account the localized earthquake effects.

Table 4-1 Modified Mercalli Intensity Scale

Intensity	Severity	Level of Damage	Richter Scale
1–4	Instrumental to Moderate	No damage.	</= 4.3
5	Rather Strong	Damage negligible. Small, unstable objects displaced or upset; some dishes and glassware broken.	4.4–4.8
6	Strong	Damage slight. Windows, dishes, glassware broken. Furniture moved or overturned. Weak plaster and masonry cracked.	4.9–5.4
7	Very Strong	Damage slight-moderate in well-built structures; considerable in poorly-built structures. Furniture and weak chimneys broken. Masonry damaged. Loose bricks, tiles, plaster, and stones will fall.	5.5–6.1
8	Destructive	Structure damage considerable, particularly to poorly built structures. Chimneys, monuments, towers, elevated tanks may fail. Frame houses moved. Trees damaged. Cracks in wet ground and steep slopes.	6.2–6.5
9	Ruinous	Structural damage severe; some will collapse. General damage to foundations. Serious damage to reservoirs. Underground pipes broken. Conspicuous cracks in ground; liquefaction.	6.6–6.9
10	Disastrous	Most masonry and frame structures/foundations destroyed. Some well-built wooden structures and bridges destroyed. Serious damage to dams, dikes, embankments. Sand and mud shifting on beaches and flat land.	7.0–7.3
11	Very Disastrous	Few or no masonry structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipelines completely out of service. Rails bent. Widespread earth slumps and landslides.	7.4–8.1
12	Catastrophic	Damage nearly total. Large rock masses displaced. Lines of sight and level distorted.	> 8.1

Masonry Types

Masonry A: Good workmanship, mortar, and design; reinforced, especially laterally, and bound together by using steel, concrete, etc.; designed to resist lateral forces.

Masonry B: Good workmanship and mortar; reinforced, but not designed in detail to resist lateral forces.

Masonry C: Ordinary workmanship and mortar; no extreme weaknesses like failing to tie in at corners, but neither reinforced nor designed against horizontal forces.

Masonry D: Weak materials, such as adobe; poor mortar; low standards of workmanship; weak horizontally.

The harmful effects of an earthquake vary with the geologic composition and manmade infrastructure of the region, as well as the amount of accumulated energy released when the earthquake occurs.

Ground motion

Ground motion is the primary cause of damage and injury during earthquakes and can result in surface rupture, liquefaction, landslides, lateral spreading, differential settlement, tsunamis, building failure, and broken gas and other utility lines, leading to fire and other collateral damage.

The intensity and severity of ground motion is dependent on the earthquake's magnitude, distance from the epicenter and underlying soil and rock properties. Areas underlain by thick, saturated, unconsolidated soils will experience greater shaking motion than areas underlain by firm bedrock.

Fires and structural failure are the most hazardous results of ground shaking. Most earthquake-induced fires start because of ruptured power lines and gas or electrically-powered stoves and equipment. Structural failure is generally the result of age and type of building construction.

Liquefaction

Liquefaction is the transformation of loose, water-saturated granular materials (such as sand or silt) from a solid to a liquid state. Liquefaction commonly, but not always, leads to ground failure. Liquefaction potential varies significantly and site-specific analysis is needed to accurately determine liquefaction potential in earthquake prone areas.

Much of the downtown in the City of Santa Cruz flood plain experienced liquefaction during the 1989 Loma Prieta earthquake. Liquefaction and severe earth shaking have been the two primary causes of damage during earthquakes in Santa Cruz.

4.3.2 Hazard Profile – Earthquakes and Liquefaction

3.2 Profiling Hazards — Requirement **§201.6(c)(2)(i)**:

The risk assessment **shall** include a description of the type, location, and extent of all natural hazards that can affect the jurisdiction.

The plan **shall** include information on previous occurrences of hazard events and on the probability of future hazard events.

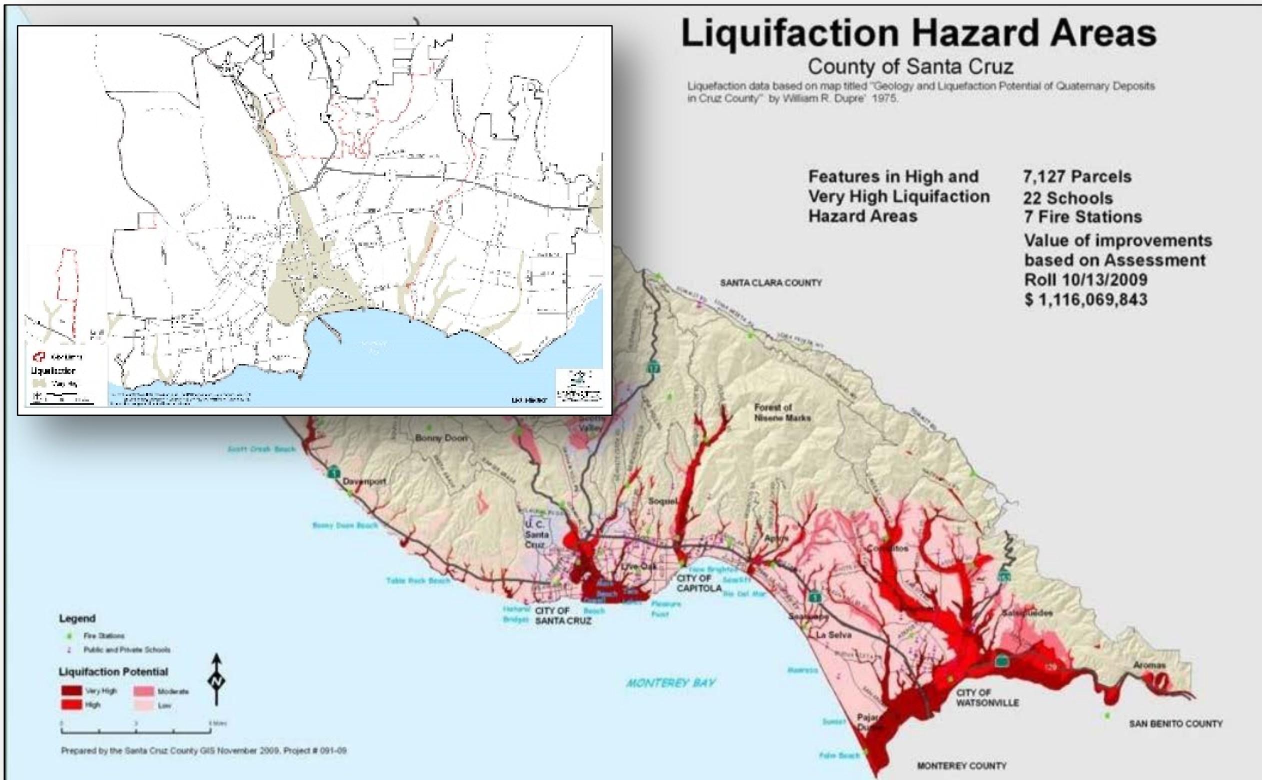


Figure 6 – Areas in Santa Cruz Potentially Vulnerable to Liquefaction

Sources: [1] City of Santa Cruz 2030 General Plan (City data) 2017
[2] County of Santa Cruz —
"Geology and Liquefaction Potential of Quaternary Deposits in [Santa] Cruz County"
William R. Dupré (1975)

Past experience has shown that the entire community is vulnerable to earthquake. Within Santa Cruz County there are several active and potentially active faults. These include the San Andreas, San Gregorio, Zayante, Ben Lomond and Butano Faults, the Monterey Bay Fault Zone, as well as numerous fault complexes and branches of these major faults.

Santa Cruz lies within 15 miles of at least six major seismic faults and fault systems, placing it in an area of high seismic risk; however there is only one fault, the Ben Lomond Fault that actually passes through the city. The Ben Lomond Fault is not considered to have moved in historic time, however, and may be inactive.

B EXTENT: MAGNITUDE OR SEVERITY

Several of the faults located in the Santa Cruz area are considered to be either possibly active (showing signs of recent geologic movement, within the last 10,000 years) or probably inactive (movement within the last two million years). However, the Hayward, Calaveras, San Gregorio and San Andreas faults are all considered historically active (movement within the last 200 years). Even a moderate earthquake in the area could result in deaths, property and environmental damage as well as the disruption of normal economic, transportation, government and community services.

The most active region and threat to the city is the San Andreas Fault zone which passes through the Santa Cruz Mountains 12 miles northeast of the city. Based on records from the 1906 San Francisco earthquake, it is estimated that the maximum credible earthquake likely to occur along the San Andreas Fault would equal 8.3 M, which represents more than 30 times the energy released by the 1989 Loma Prieta Earthquake. The city was one of the hardest hit communities during that earthquake. This is the highest magnitude earthquake expected in the region but it is estimated that the Hayward, Calaveras and San Gregorio faults are all capable of generating earthquakes greater than 7.4 M.

C PREVIOUS OCCURRENCES

The following is a list of previous events, dates, severity, level of damage, duration, sources of information used, and maps (where available) to show areas affected. While Santa Cruz has sustained numerous earthquakes throughout its history, the two most destructive ones were the 1906 San Francisco earthquake and the 1989 Loma Prieta earthquake.

April 18, 1906: (Richter Magnitude: 8.3)
No recorded deaths in Santa Cruz but the courthouse was almost destroyed; about one third of the chimneys within the city were destroyed or damaged; there was major landsliding with gaping cracks in the earth, especially along the water; bridges were destroyed; and the water supply was shut off by broken mains and pipes.

October 1926: (Richter Magnitude: 6.1)
Two large earthquakes occurred during this year. Three of the aftershocks cracked plaster in Santa Cruz, almost bringing down the chimneys of numerous buildings. It broke plate glass windows along Pacific Avenue. The city water main broke at Laguna Creek and articles fell from shelves at stores.

October 17, 1989 (Richter Magnitude: 7.1)
Two people died in Santa Cruz as a direct result of this earthquake. In the greater San Francisco/Oakland Bay Area, there were sixty-two fatalities. The earthquake epicenter was located approximately 10 miles east of the city center. The earthquake destroyed much of the historic downtown and many areas of the city were very badly damaged. Roads in and out of the city were impassable and many residents lost power and water for up to a week.

Isoseismal Map — Santa Cruz Mountains (Loma Prieta), California
UTC (Local 10/17/1989) [6] Magnitude 6.9 Intensity IX

(NOTE: An isoseismal [line] is a contour or line on a map bounding points of equal intensity for a particular earthquake.)

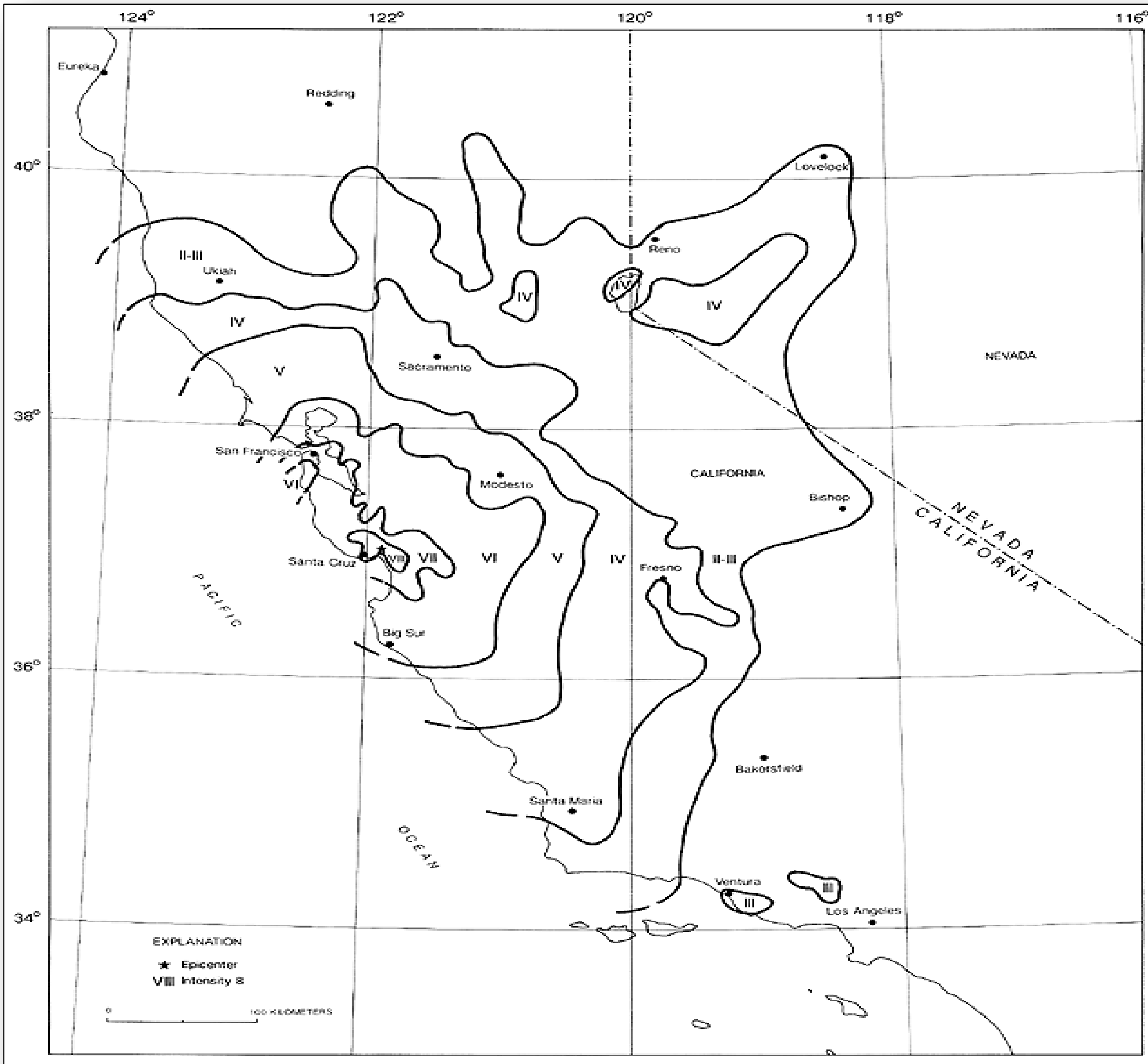


Figure 7 – Intensity and Magnitude of the 1989 Loma Prieta Earthquake in Santa Cruz

Source: Department of the Interior U.S. Geological Survey
Preliminary isoseismal map for the Santa Cruz (Loma Prieta). California, earthquake of October 18, 1989 UTC

D PROBABILITY OF FUTURE EVENTS

The City lies within 15 miles of at least six (6) major seismic faults and fault systems, placing it in an area of high seismic risk. Because earthquakes can cause severe damage over a long distance, the Santa Cruz area remains at risk from continued seismic activity along the many faults in the region.

The reduction of seismic stresses that occurred in the Loma Prieta earthquake did nothing to relieve, and possibly increased, stresses within other faults, including other sections of the San Andreas Fault. As a result, it is expected that Santa Cruz will be subjected to violent, earthquake-induced ground shaking in the future.

On the basis of research conducted since the 1989 Loma Prieta earthquake, U.S. Geological Survey (USGS) and other scientists conclude that there is a 62% probability of at least one magnitude 6.7 or greater quake, capable of causing widespread damage, striking the San Francisco Bay region (including Santa Cruz) before 2032. Major quakes may occur in any part of this region. This emphasizes the urgency for all communities in the region to continue preparing for earthquakes.[7]

The USGS, the California Office of Emergency Services, the California Geological Survey and the Association of Bay Area Governments jointly conducted a loss estimation study focused on the ten most likely damaging earthquakes. These earthquakes occur on six of the seven major fault systems in the area and range in size from a magnitude 6.7 on a blind thrust underlying Mount Diablo to a magnitude 7.9 repeat of the 1906 rupture on the San Andreas Fault in northern California. Their 30-year probabilities range from a high of 15.2% for a M7.0 rupture of the Rodger’s Creek fault to 3.5% for a M7.4 combined rupture of the Peninsula and Santa Cruz Mountains segment of the San Andreas. The ten most likely earthquakes and their 30-year probabilities are:[8]

Table 4-2 Ten most likely damaging Earthquake scenarios in California

Ten most likely damaging Earthquake scenarios	30-year probability	Magnitude
Rodgers Creek	15.2%	7.0
Northern Calaveras	12.4%	6.8
Southern Hayward (*possible repeat of 1868 earthquake*)	11.3%	6.7
Northern + Southern Hayward	8.5%	6.9
Mt. Diablo	7.5%	6.7
Green Valley-Concord	6.0%	6.7
San Andreas: Entire Northern California segment (*possible repeat of 1906 earthquake*)	4.7%	7.9
San Andreas: Peninsula segment (*possible repeat of 1838 earthquake*)	4.4%	7.2
Northern San Gregorio segment	3.9%	7.2
San Andreas: Peninsula + Santa Cruz segment	3.5%	7.4

Because the ten most likely future earthquakes in the Bay Area occur on faults throughout the region, the impact and potential losses reported here reveal significant risk for the entire Bay Area region including the City of Santa Cruz.

4.3.3 Assessing Vulnerability: Overview

3.3 Assessing Vulnerability: Overview — Requirement §201.6(c)(2)(ii): The risk assessment **shall** include a description of the jurisdiction’s vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description **shall** include an overall summary of each hazard and its impact on the community.

A OVERALL SUMMARY OF VULNERABILITY TO EARTHQUAKE

The vulnerability of a community to earthquake hazard is based on a variety of factors including proximity to active and inactive faults, the age of structures, the density of the population and development, the value of property and infrastructure, the construction materials used in residential and non-residential buildings, and the location of critical facilities in a community.

Recent history indicates that Santa Cruz has a very high vulnerability to earthquakes due to proximity to faults, density of population and downtown development in the San Lorenzo River floodplain which is subject to liquefaction. A number of buildings in the downtown were rebuilt or seismically retrofitted after the 1989 Loma Prieta Earthquake which damaged or destroyed much of the old downtown.

The October 17, 1989 Loma Prieta earthquake was responsible for 62 deaths (including three in the City of Santa Cruz) and 3,757 injuries. In addition, over $6 billion in damage was reported including damage to 18,306 houses and 2,575 businesses. Approximately 12,053 people were displaced.

The most intense damage was confined to liquefaction areas where buildings and other structures were situated on top of loosely consolidated, water saturated soils. Loosely consolidated soils tend to amplify shaking and increase structural damage. Water saturated soils compound the problem due to their susceptibility to liquefaction and corresponding loss of bearing strength.

During the Loma Prieta earthquake, extensive liquefaction occurred along the shoreline of the Monterey Bay. Most of the City of Santa Cruz downtown along the San Lorenzo River is in a liquefaction area. Liquefaction is a phenomenon in which the strength and stiffness of a soil is reduced by earthquake shaking or other rapid loading. Liquefaction has been responsible for tremendous amounts of damage in earthquakes around the world including the City of Santa Cruz.

Liquefaction occurs in saturated soils, that is, soils in which the space between individual particles is completely filled with water. This water exerts a pressure on the soil particles that influences how tightly the particles themselves are pressed together. Prior to an earthquake, the water pressure is relatively low. However, earthquake shaking can cause the water pressure to increase to the point where the soil particles can readily move with respect to each other. When liquefaction occurs, the strength of the soil decreases and, the ability of a soil deposit to support foundations for buildings and bridges is reduced.[9] Some examples of these phenomena are shown below.

Failure and cracks induced by liquefaction have been observed in the past (*see below*: photographers unknown). These images, probably from the 1906 event, show cracks formed by liquefaction at the San Lorenzo River.[10, 11]

4.3.4 Assessing Vulnerability: Identifying Structures

A TYPES AND NUMBERS OF EXISTING BUILDINGS, FACILITIES AND INFRASTRUCTURE

Past experience has shown that the entire community is vulnerable to earthquake. The entire downtown commercial area is in a liquefaction hazard area. The remainder of the town is at risk for severe ground shaking as indicated by the maps below showing the probability of earthquake impacts to the Santa Cruz area within the next 50 years.

These estimates were formulated using HAZUS, a geographic information system-based, nationally standardized, loss estimation tool developed by FEMA. They are recent California Geological Survey maps and are limited to ground motion-induced losses to *buildings only*. In other words, the losses to other elements of the built environment, such as transportation, lifeline and communication facilities are not reported. Furthermore, the losses reported are only the *direct economic losses* due to building damage, which consist of *capital stock loss* and *income loss*.

This survey reviews 34 potential earthquake scenarios. Two of the ten most likely earthquake scenarios, most damaging to Santa Cruz are shown on the following maps.

Scenario N-9 shows a possible repeat of the 1906 San Francisco earthquake and the intensity and potential damage to the City of Santa Cruz. The map indicates that the intensity would be up to IX or X which represents violent or extreme perceived shaking and very heavy potential damage. The next map shows the peak ground acceleration for this earthquake and the following two maps show the estimated building damage and economic loss as a result of the Sceniario-9 earthquake.

Scenario N-7 shows the projected impacts of an earthquake along the Santa Cruz Mountains + Peninsula + North Coast and the potential damage to the City of Santa Cruz. The map indicates that the intensity would be VIII or IX which represents severe to violent perceived shaking and moderate to heavy damage.

The next map shows peak ground acceleration for this earthquake scenario and the following two maps show the estimated building damage and economic loss as a result of the Scenario N-7 earthquake.

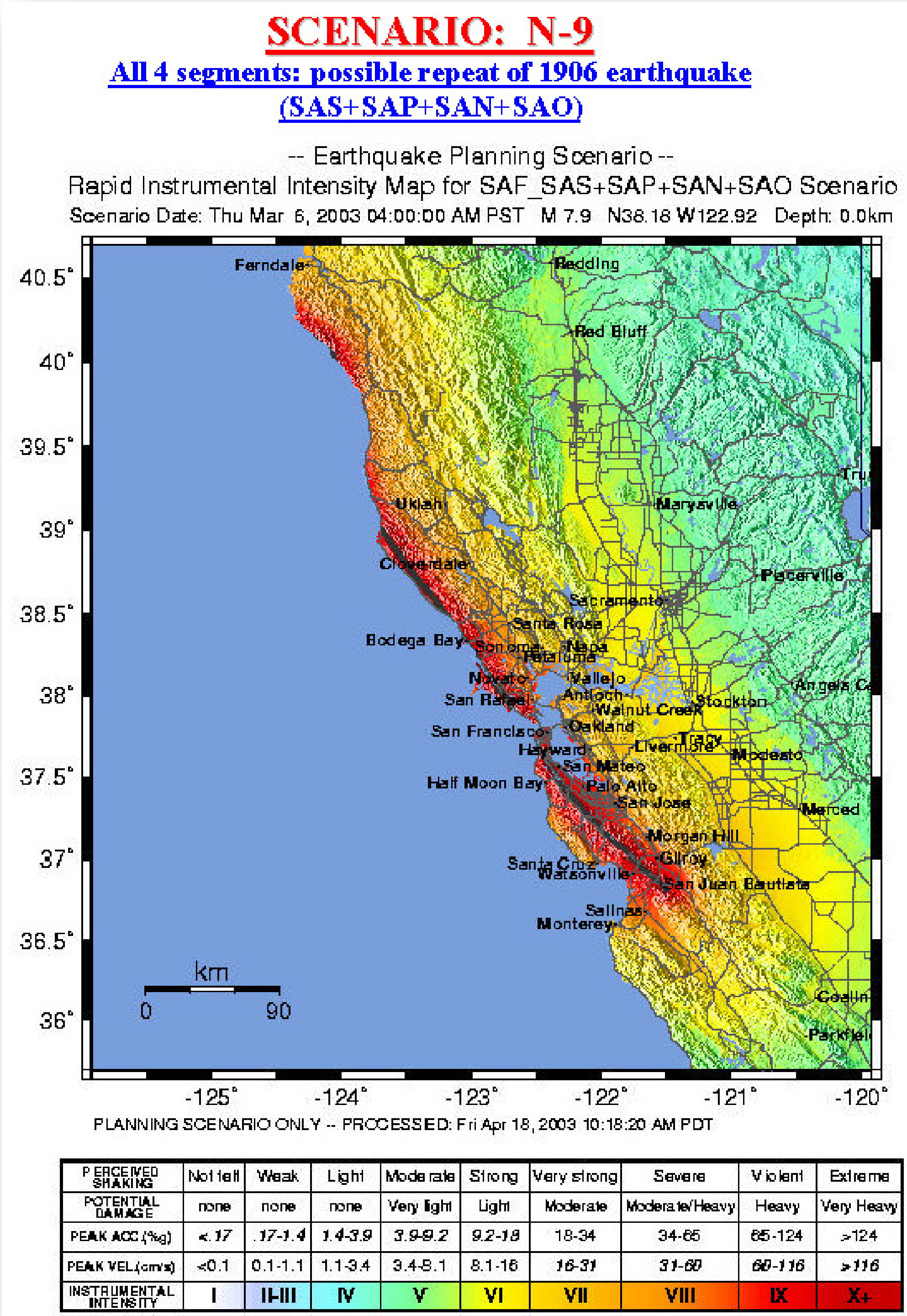


Figure 8 – Scenario N-9 Repeat of 1906 Earthquake

Source: State of California Department of Conservation (web link: **ftp://ftp.consrv.ca.gov/pub/dmg/rgmp/NC1-Scenario-Losses.pdf** (year: unknown)

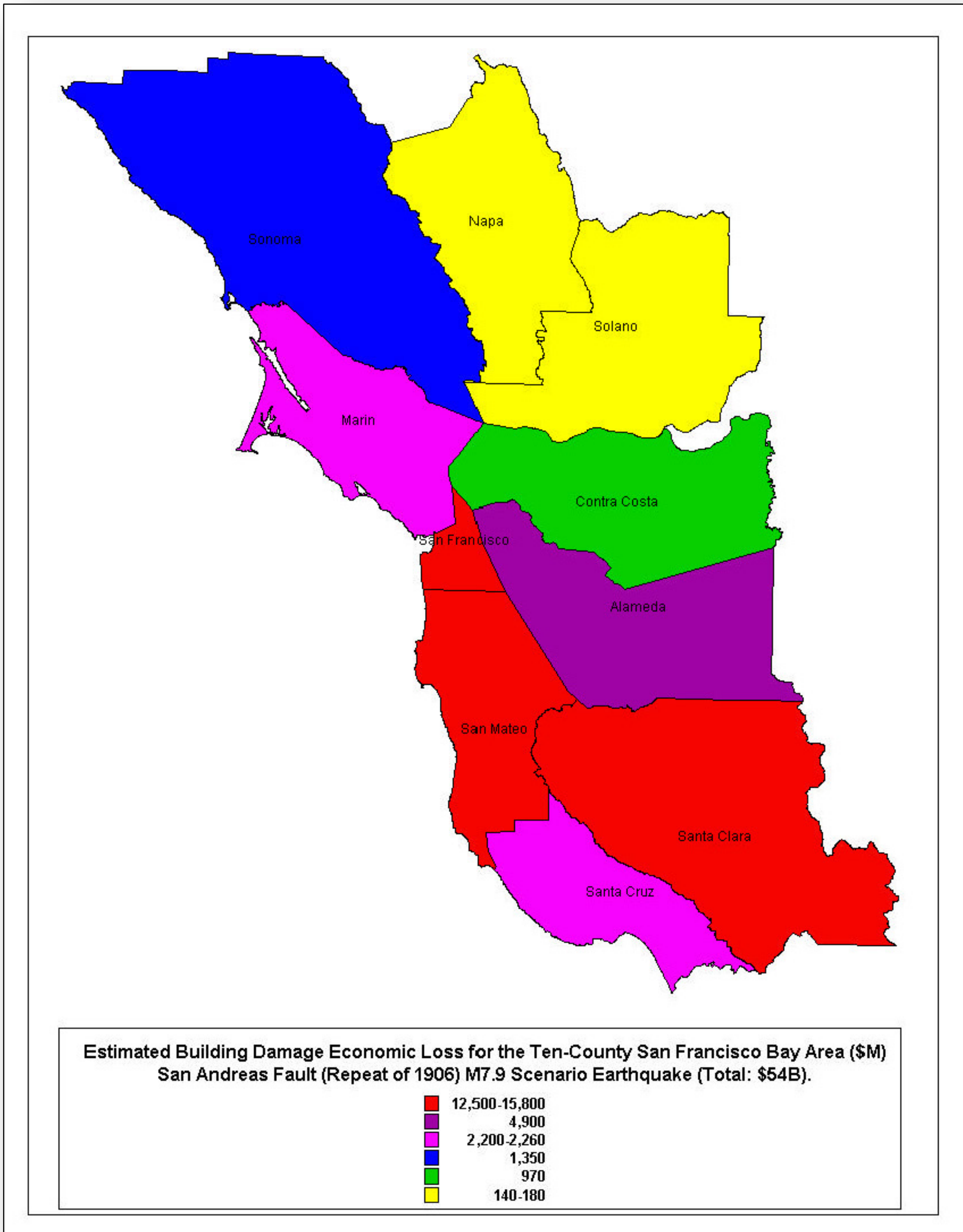


Figure 9 – Scenario N-9 Repeat of 1906 Earthquake — Building Economic Loss by County
Source: State of California Department of Conservation (web link: **ftp://ftp.consrv.ca.gov/pub/dmg/rgmp/NC1-Scenario-Losses.pdf** (year: unknown)

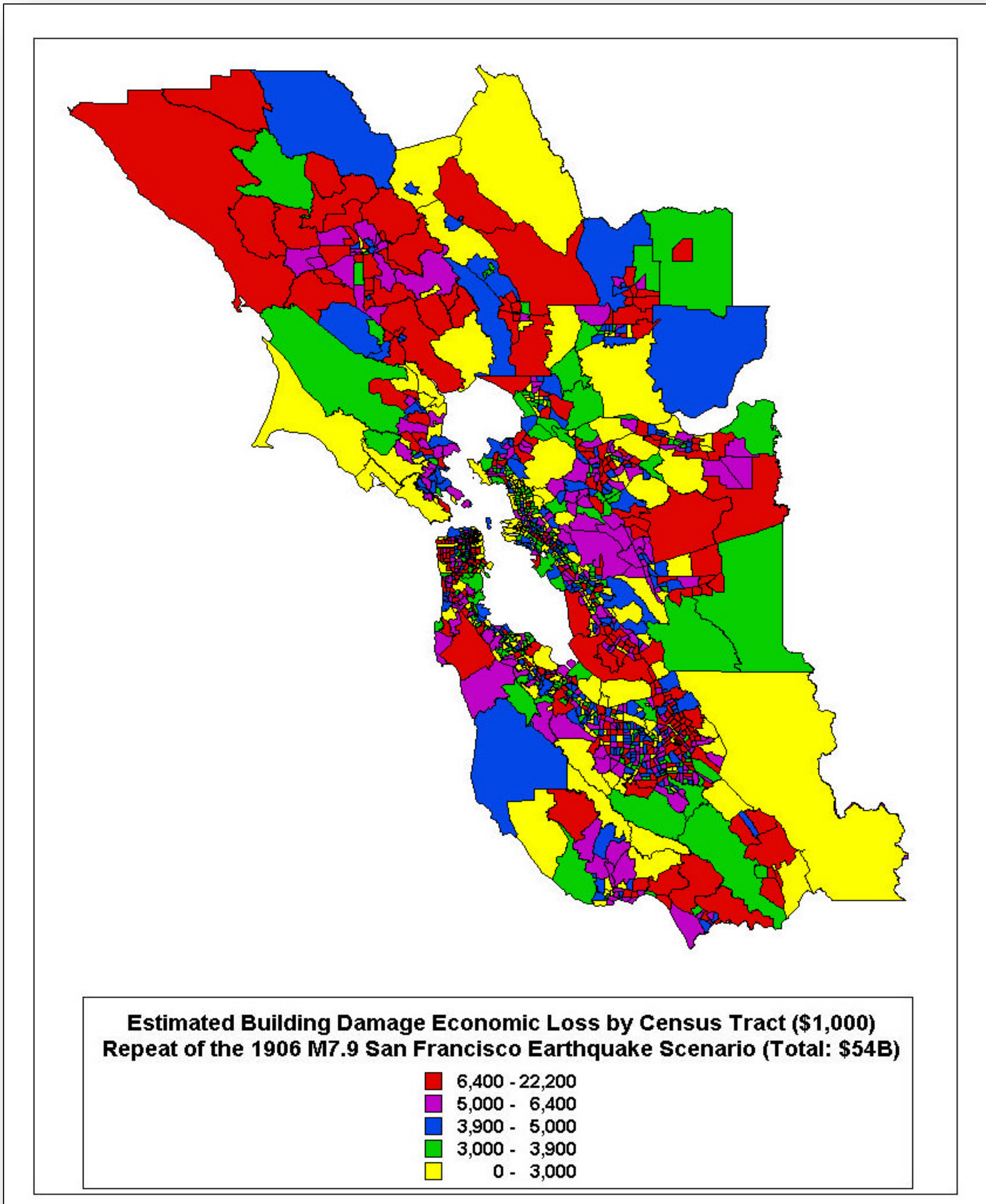


Figure 10 – Scenario N-9 Repeat of 1906 Earthquake Loss by Census Tract

Source: State of California Department of Conservation (web link: **ftp://ftp.consrv.ca.gov/pub/dmg/rgmp/NC1-Scenario-Losses.pdf** (year: unknown)

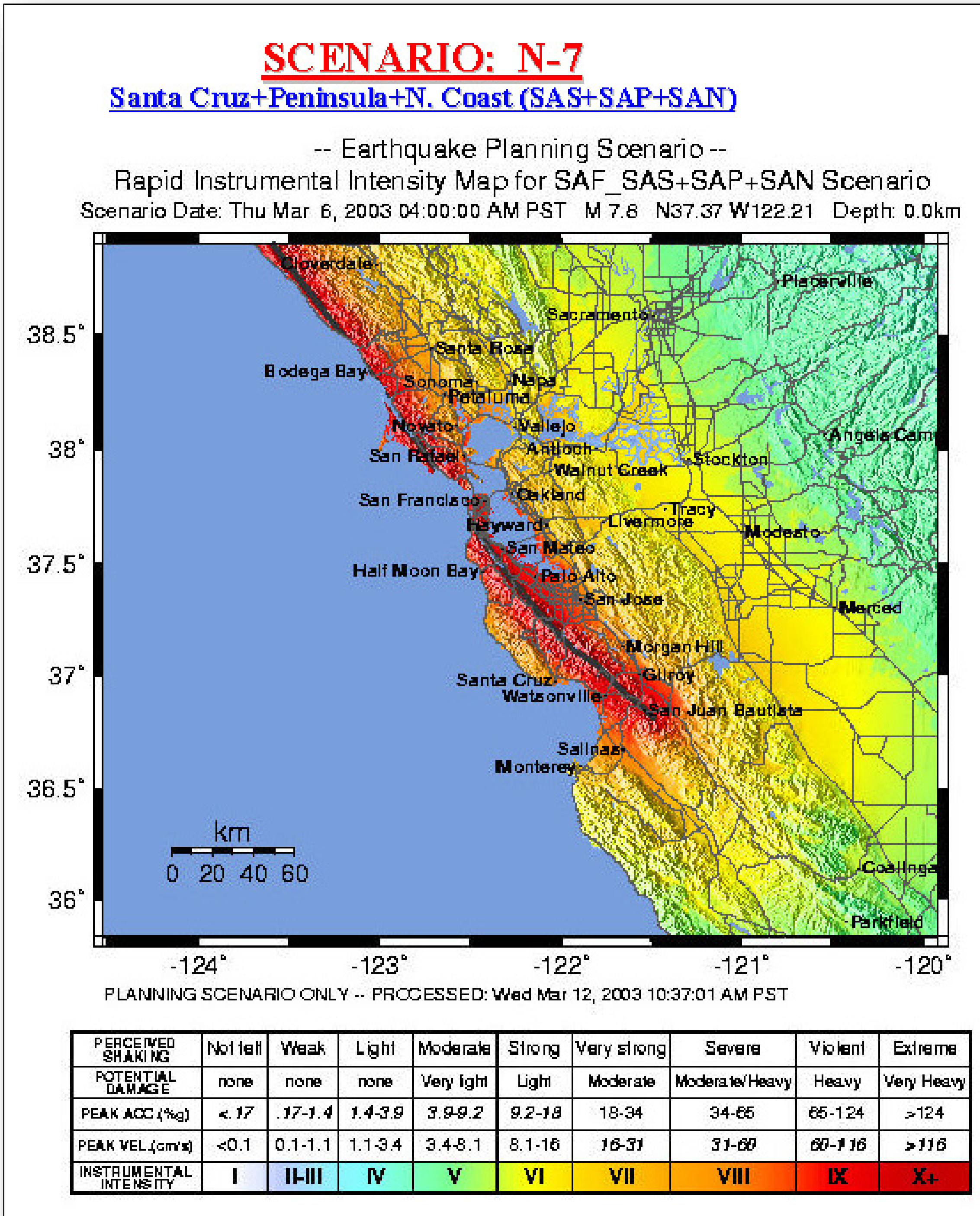


Figure 11 – Scenario N-7 Santa Cruz Mountains

Source: State of California Department of Conservation (web link: ftp://ftp.consrv.ca.gov/pub/dmg/rgmp/NC1-Scenario-Losses.pdf (year: unknown)

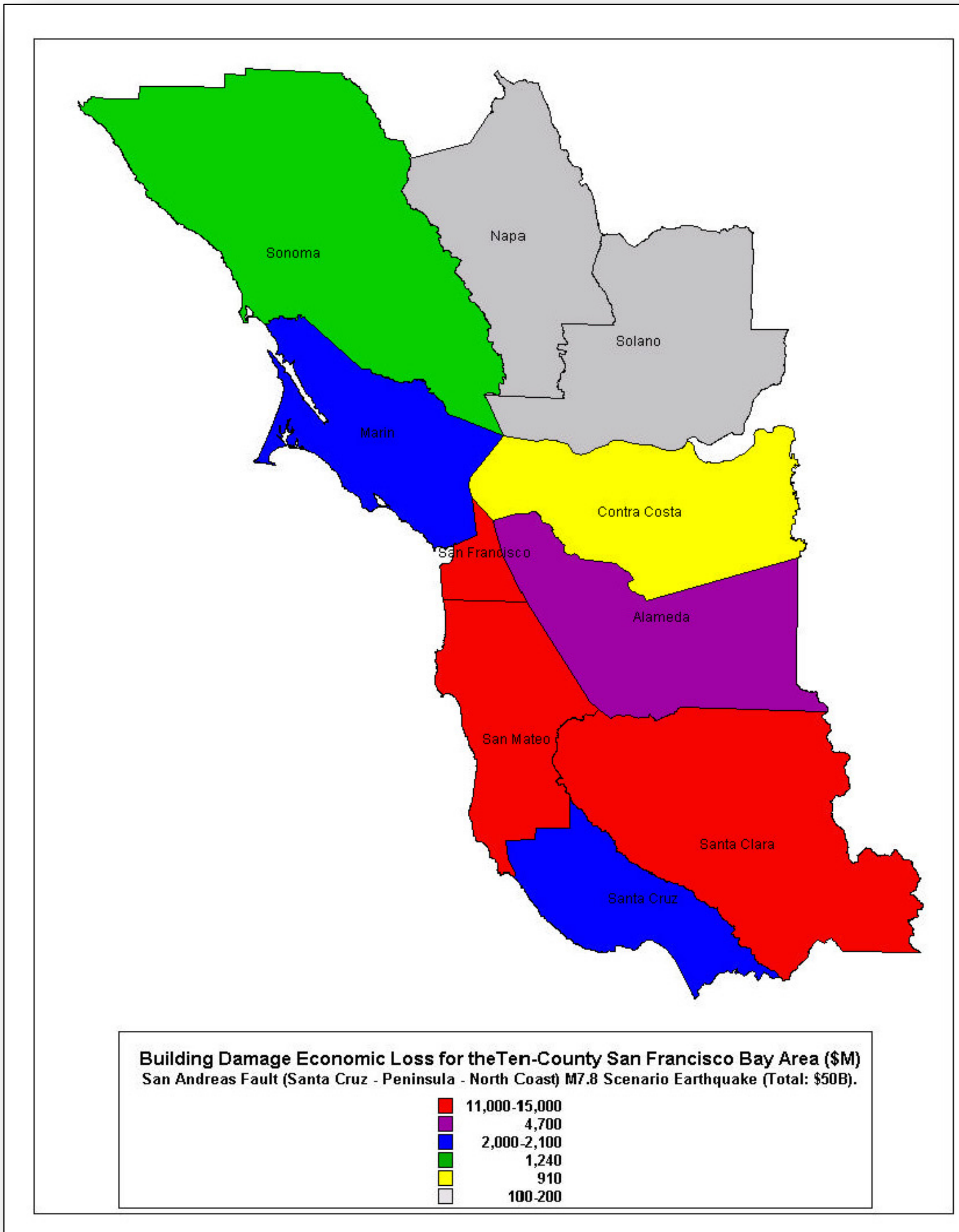


Figure 12 – Scenario N-7 Santa Cruz Mountains — Building Economic Loss by County
Source: State of California Department of Conservation (web link: ftp://ftp.consrv.ca.gov/pub/dmg/rgmp/NC1-Scenario-Losses.pdf (year: unknown)

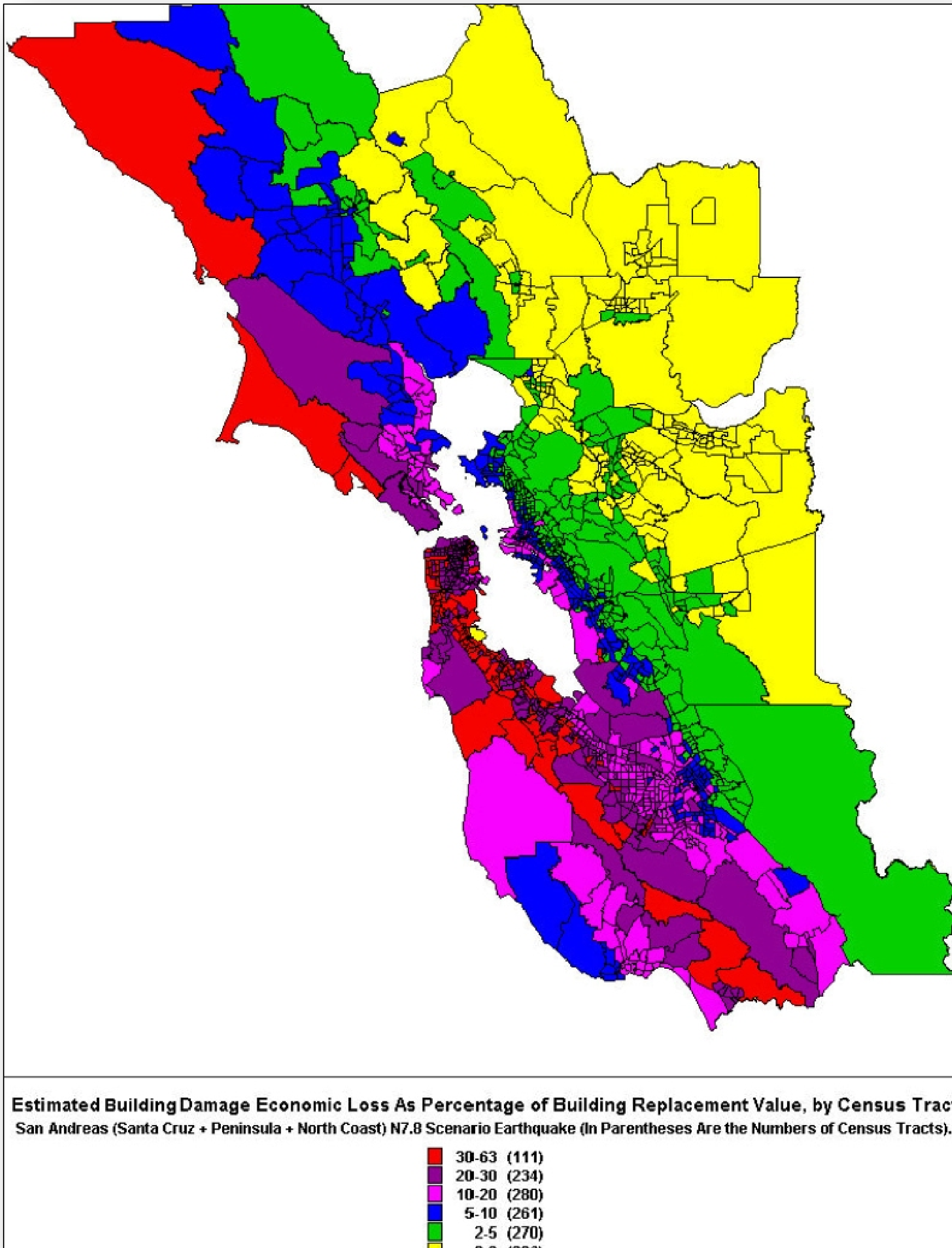


Figure 13 – Scenario N-7 Santa Cruz Mountains — Building Economic Loss by Census Tract
Source: State of California Department of Conservation (web link: **ftp://ftp.consrv.ca.gov/pub/dmg/rgmp/NC1-Scenario-Losses.pdf** (year: unknown)

4.3.5 Assessing Vulnerability: Estimating Potential Losses

3.5 Assessing Vulnerability: Estimating Potential Losses: — Requirement §201.6(c)(2)(ii)(B):

The plan **should** describe vulnerability in terms of an estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(i)(A) of this section and a description of the methodology used to prepare the estimate.

A POTENTIAL DOLLAR LOSSES TO VULNERABLE STRUCTURES

Table 4-3 Earthquake potential loss inventory

Inventory Assets				
EARTHQUAKE				
	# of Parcels	**# of Structures**	**Critical Structures**	**Loss in Value$***
Type	**Entire Community**	**Total**	**Total**	**Hazard**
Residential	14,916	17,363		$9,263,773,000
Commercial	1,54	1,310		$2,309,879,000
Industrial	307	299		$495,671,000
Agricultural	5	51		$29,942,000
Religion	56	99		$168,168,000
Government	217	30		$85,229,000
Education	228	65		$188,840,000
Total	**17,253**	**19,217**	**35**	**$12,541,502,000**
# of People	62,752			
Date: Census American Community Survey 2015				
Total = total number of structures, residents, values within the entire community				
Parcel Data is from January 2017. The entire community is within the earthquake hazard area.				
*Building Count/Total Replacement Value data is from 2014.				

B METHODOLOGY USED TO PREPARE ESTIMATE

Parcel Valuation:
Total Building Replacement Value (Building and Contents) and Building Count (Structure Count) from HAZUS-MH 3.2 Release 14.2.0. This data is from 2014.

Population:
Census population blocks were reduced to center points. If a hazard intersected a center point, that population was counted.

The losses to other elements of the built environment, such as transportation, lifeline and communication facilities are not reported. Furthermore, the losses reported are only the *direct economic losses* due to building damage, which consist of *capital stock loss* and *income loss*.

Indirect economic losses, representing the losses due to various forms of post-earthquake socioeconomic disruptions (such as employment and income, insurance and financial aids, construction, production and import-export of goods and services) are not included in the estimates reported. This is because of the higher level of uncertainty associated with the indirect losses, as compared to the direct losses. Therefore, it is expected that once the indirect building economic losses, the economic losses to non-building facilities, and the contributions of all earthquake hazards are taken into account, the estimated economic losses would be several times the numbers presented.[12]

Detailed results for all scenario earthquakes and for the State-wide annual losses are available on the CGS website.[13]

Among the 34 scenario earthquakes of the San Francisco Bay Area (SFBA), a repeat of the 1906 earthquake results in the largest economic loss for the ten SFBA counties. It would rupture four segments of the San Andreas fault and would cause approximately $54 billion of economic loss due to building damage. A number of other earthquakes on the San Andreas fault, rupturing different combinations of these four segments are also feasible. Should one occur, it would result in an estimated loss ranging from a few billion dollars to $50 billion. Other potentially damaging earthquakes in the SFBA are:

- A magnitude 6.9 event rupturing the entire Hayward fault causing $23 billion in losses;
- A magnitude 7.3 earthquake rupturing the entire Hayward fault and the Rodgers Creek fault causing $34 billion in losses.

Estimates were calculated using HAZUS version MH 3.2, Release 14.2.0, and uses 2010 census data. This information in HAZUS is, for the most part, derived from 2010 national census data. Using this process the most severe potential earthquake near Santa Cruz estimates a loss of over $9 billion dollars for the county. The City of Santa Cruz represents 20 percent of that population and has within its boundaries significantly more than 20 percent of the structures as it is the commercial center of the county.

4.3.6 ASSESSING VULNERABILITY: ANALYZING DEVELOPMENT TRENDS

> **3.6 Assessing Vulnerability: Analyzing Development Trends — Requirement §201.6(c)(2)(ii)(C):**
>
> The plan **should** describe vulnerability in terms of providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.

C DESCRIPTION OF LAND-USES AND DEVELOPMENT TRENDS

The City of Santa Cruz is a compact urban community that is surrounded by natural barriers to outward expansion including the Santa Cruz Mountains, the Pacific Ocean and a designated greenbelt. "Ongoing population growth… has been mirrored by an increase in urbanization for the Monterey Bay area. Development patterns in the coastal zone since the 1970s confirm these overall urbanizing trends."[14]

New development has occurred within or adjacent to the urban services line (i.e., the boundary point for such infrastructure as gas, water, and sewage hook-ups). In Santa Cruz, most development is now infill or reuse development.

Since the 1989 Loma Prieta earthquake all commercial and public buildings have been replaced or seismically retrofitted. Seismic safety standards are a requirement for all building permits. As infrastructure is repaired or replaced updated seismic safety standards are incorporated. Seismic retrofits have reduced overall vulnerability in the community.

4.4.0 MITIGATION STRATEGY

> **4.0 Mitigation Strategy — Requirement §201.6(c)(3):**
>
> The plan **shall** include a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs and resources, and its ability to expand on and improve these existing tools.

The primary mitigation strategy to avoid or reduce damage from earthquake is continuation of design review and code enforcement to meet current seismic standards, including adequate geotechnical monitoring protocols to insure structural integrity.

Mapping of liquefaction areas in Santa Cruz have been updated in this plan and represent a more accurate mapping of potential liquefaction areas. The inclusion of an updated liquefaction map was noted as an important goal of the 2007 LHMP.

4.4.1 Mitigation Goals

4.1 Local Hazard Mitigation Goals — Requirement §201.6(c)(3)(i):

The hazard mitigation strategy **shall** include a description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.

Earthquake Goals:

Earthquake 1 — Avoid or reduce the potential for life loss, injury, property or economic damage to Santa Cruz from earthquakes.

Earthquake 2 — Encourage mitigation activities that increase disaster resilience to earthquake and liquefaction. (A-6)

4.4.2 Identification and Analysis of Mitigation Actions

4.2 Identification and Analysis of Mitigation Actions — Requirement §201.6(c)(3)(ii):

The mitigation strategy **shall** include a section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure.

Earthquake Mitigation Actions:

Earthquake is one of the most significant threats to Santa Cruz. The following Actions (noted in parentheses), are listed in Part 4, Chapter 13: Mitigation Strategies. They are critical to the future safety of Santa Cruz:

- Coordinate preparedness efforts with other agencies. (A-2)
- Upgrade sewer, water and other infrastructure to withstand seismic shaking. (A-10)
- Continue retrofitting all non-complying unreinforced masonry buildings. (C-8)
- Upgrade seismic safety of all emergency use and critical structures. (C-9)

In regard to what has taken place since 2012 as it relates to earthquake mitigation for buildings and structures under the authority of the Building and Safety Division, the City of Santa Cruz adopted the most recent California Buildings Standards Code. These codes include structural design standards for seismic requirements. They also reference other applicable standards, such as ASCE7 (American Society of Civil Engineers). Current codes in use are the 2016 California Building Standards Code adopted through Santa Cruz Municipal Code, Title 18 (18.04.030 Adoption of Codes). Building permits are required by both the California Residential Code and the California Building code, resulting in structural/seismic design requirements for residential and nonresidential buildings and structures. Applications for permits include plans and supporting documentation showing seismic design compliance. Structural design is typically accomplished by a Registered Engineer. Plans are reviewed and approved by professional plan review staff. Inspections are accomplished by city inspection staff. Additionally, special inspection/material testing and structural observation may be accomplished by qualified third party inspection agencies and the project engineer as required.

CHAPTER 5: WILDFIRES

5.3.0 Wildfire Risk Assessment

5.3.1 Identifying Wildfire Hazards

3.1 Identifying Hazards — Requirement §201.6(c)(2)(i):

The risk assessment **shall** include a description of the type, location, and extent of all natural hazards that can affect the jurisdiction.

The plan **shall** include information on previous occurrences of hazard events and on the probability of future hazard events.

Wildland fire may be defined as any unwanted fire involving outdoor vegetation. While it is often thought of as occurring in forests, rangelands or crop fields, it may also occur in areas such as vacant lots, highway medians, parks and golf courses. With residential development spreading into pristine areas, a relatively new phenomenon has been created: the wildland/urban interface. This phenomenon has changed the nature of the wildland fire problem in some very significant ways. Both the life hazard and the potential economic losses in wildland areas have increased greatly, and the increase in human activity has multiplied the number and variety of potential sources of ignition.

Wildland fires are influenced by three factors: fuel, weather and topography. The spread of wildland fires depends on the type of fuel that exists within the area in the form of grasses, brush and trees. Wildland fire behavior is also influenced by local weather which can modify the burn rate (how fast the fire burns.) Examples of weather incidents that affect wildland fires are atmospheric stability, inversions, thunderstorms, relative humidity and wind. Finally, the severity of wildland fires is influenced by topography including slope, aspect, chimneys and drainages, and the accessibility of the location.

Priorities in the event of a wildfire are life safety, preservation of property and resource conservation. Life safety includes the potential for evacuation, sheltering in place (finding and directing citizens to a location safe from the threat of fire) and providing evacuation to safe refuge. Property conservation includes triage (evaluation and determination of priority of response) of threatened structures as well as evaluation of types of structures in surrounding areas. Natural resource conservation includes assessing the risk to timber, crops, wildlife, wetlands and pasture land.

CLIMATE ADAPTATION CONSIDERATIONS

As noted in the City of Santa Cruz Climate Adaption Plan (*see* Appendix P), the impacts of changing precipitation patterns will exacerbate wildland fire threats due to the potential of longer and dryer summers or wetter winters. Additionally, rising temperatures may contribute to increased wildland fires. It has been noted that the risk for large wildfires could increase by as much as 55 percent if temperatures rise to what is considered a medium warming range. Such a percent increase is twice as high as expected if temperatures only increased into the lower warming range. (*see* CalAdapt.org)

5.3.2 PROFILING WILDFIRE HAZARD EVENTS

A LOCATION

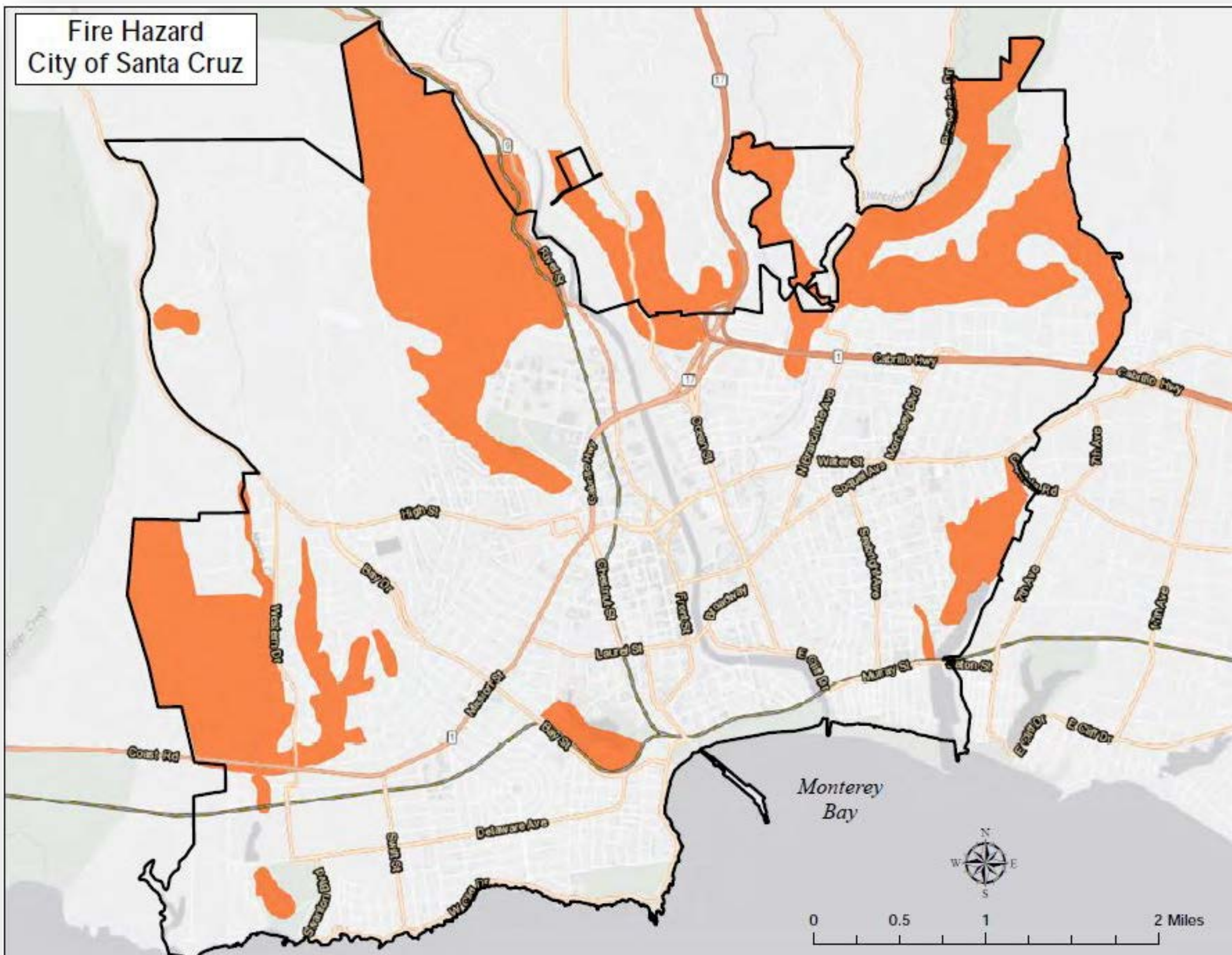


Figure 14 – Wildfire Hazard Areas within the City of Santa Cruz

Sources: [1] City of Santa Cruz 2030 General Plan
[2] California Department of Forestry and Fire Protection (CDF; 2009)
[3] City of Santa Cruz Fire Department (modified 2017)

Within the City of Santa Cruz there are five wildland/urban interface areas including three areas designated as *mutual threat zones* (also called *mutual response zone*). Mutual threat/response zones are defined as geographical areas where a wildfire would threaten property within the Santa Cruz fire protection district as well as property covered by another fire protection service.

For major emergencies that require more resources than can be provided by a single agency, the City of Santa Cruz, Santa Cruz County, the University of California at Santa Cruz and the State of California have an extensive mutual aid and emergency coordination system. Developed and managed in cooperation with the State Office of Emergency Services, this system allows departments and districts to share personnel and equipment as needed to address and control emergencies.

Shared Fire Department Command, Training, Resources

In September 2011, the City of Santa Cruz and UC Santa Cruz determined that it was in the best interest of both agencies to consolidate the local provision of fire prevention and suppression activities, emergency medical services and emergency/disaster management. Both agencies had these same responsibilities within their respective boundaries.

Due to the proximity of the two fire service departments to one another and, their similar organizational elements, both jurisdictions determined that it was in their best interests to cooperate in sharing fire management functions; as well as supervision of operations, training, fire prevention, administration, fiscal management and disaster preparedness.

On September 27, 2011, the Santa Cruz City Council passed and adopted a Resolution (NS-28,405) merging the two fire departments, in a two-year pilot process. This effectively eliminated redundancy and duplication of efforts and provided opportunities for cost savings and an increased level of service for each party, and their constituents. The newly shared fire command services enhance the City of Santa Cruz' ability to mitigate fire danger in the city and surrounding greenbelt areas.

On July 2, 2014 both agencies entered into a ten-year contract for fire and EMS response services (excluding prevention).

Mutual Threat Zones

Mutual threat zones (described above), are delineated in the Wildland Pre-Suppression Plan[15] for the mutual threat zone areas in and around DeLaveaga Park, the Pogonip property, and the Arroyo Seco/Meder Canyon area (*see* Figure 14). This plan is used to identify non-State Responsibility Areas* in which any fire is considered a threat to adjacent State Responsibility Areas. These geographic areas are designated mutual threat zones because of the urban development that has occurred along their canyons and the vegetation that is considered significant. The main populated areas of the University of California Santa Cruz are considered Local Responsibility, but the rest of the property is considered as State Responsibility area.

Source: CALFIRE — California Department of Forestry and Fire Protection

* The State Responsibility Area (SRA) is the area of the state where the State of California is financially responsible for the prevention and suppression of wildfires. SRA does not include lands within city boundaries or in federal ownership. (State Responsibility Area)

Wildland fires also present a risk to open space areas within the City of Santa Cruz and adjacent to residential homes. Additional areas of concern for these wildland/urban interface zones include the Arana Gulch property, Lighthouse Field, the Moore Creek Preserve as well as other smaller wildland/urban interface areas throughout the city. It should also be noted that there are City of Santa Cruz water service areas and water infrastructure areas that are located outside of the City limits that are potentially threatened by wildland fires.

B EXTENT: MAGNITUDE OR SEVERITY

The potential magnitude and severity of future fires could be predicted from experiences gained from recent fires in 2008/2009/2016 which occurred in the County of Santa Cruz. A few of these fires bordered jurisdictional boundary to the City of Santa Cruz. In a few of these fires, spotting exceeded 1 mile, with some flame lengths exceeding 100 feet. In 2008, over 75 structures were destroyed on three fires alone. During the 2008/2009 fire seasons over 13,000 acres have burned in five major fires in Santa Cruz County. In 2016 the second Loma Fire burned three homes, 2,250 acres and several vehicles.

Although the City of Santa Cruz Fire Department responds annually to about 50 vegetation type fires the opportunity for these events to become significant have been recognized over the past few fire seasons. Suppression costs to contain and extinguish each of these fires exceeded $60 million dollars. The state and local cost incurred to respond to these fires were covered by the Federal Fire Management Assistance Grant and California Disaster Assistance Act.

According to the *Meder Canyon Vegetation Management Plan*, prepared by Wildland Resource Management (2004), and the *Wildland Fire Safety Plan, DeLaveaga Park Area* prepared by the Hunt Research Corporation (1995), the potential for a significant wildland fire exists in and around various areas of Santa Cruz. Because some of these canyon areas have steep slopes with dense stands of eucalyptus trees, conifers, chaparral species and other vegetation, the potential for a fire with the intensity and effect of the 1991 Oakland Hills fire exists and many structures could be threatened. There are a large number of homes at the top of steep slopes.

Expected fire behavior in and around the canyons described above indicates that fire spread will be rapid and will run uphill toward structures. Without fuels modification and/or management, eucalyptus litter, shrubs and un-mowed grass would generate enough heat to cause shrubs, eucalyptus, or oak canopies to ignite, distributing embers widely and producing enough heat to potentially involve structures. Un-mowed grass and eucalyptus litter comprise the highest flash point type of fuels encountered in Santa Cruz.

Trees with low branches, and shrubs — particularly coyote brush and poison oak — are most likely to serve as “ladder fuel” to enable fires beneath to spread into the tree canopy or crown. Should fire become involved in the crown or tree canopy, embers may be expected to be cast throughout the neighborhood and potentially cause several additional fires. In such a case the burning debris may travel up to 1.5 miles away in a wind of 20 mph at ground level during a crown fire according to the Santa Cruz Fire Department.

In most of the wildland fire risk areas the fuels surrounding these areas have high moisture content due to the area’s marine influence. Winds tend to blow from the ocean upslope. However, in the fall, *sundowner winds*, defined as strong, warming, downslope winds that develop over the southern slopes of mountains in late afternoons and evenings that pose a very serious threat during the height of fire season, can occur from the north/northeast towards the ocean. Wind speeds can be 20 mph or more. Temperatures can be 80º or more. In Santa Cruz, fuel moistures have been recorded as low as 34% by the Santa Cruz Fire Department.

C PREVIOUS OCCURRENCES

Recent Significant Wildland fires in the City of Santa Cruz

- 1990 — Meder Canyon Fire — Several acres consumed in 20 minutes

A number of other wildland fires in the Santa Cruz area including the Santa Cruz Mountains have been a concern to the City of Santa Cruz.

- 2016......................... Loma Fire..............2,220 acres consumed
- 2009......................... Loma Fire.................485 acres consumed
- 2009..................Lockheed Fire..............7,819 acres consumed
- 2008...................... Trabing Fire.................630 acres consumed
- 2008........................Martin Fire.................520 acres consumed
- 2008......................Summit Fire..............4,270 acres consumed

D PROBABILITY OF FUTURE EVENTS

Despite the fact that there has not been a recent significant wildland fire within the city limits, residential development continues to spread into wildland/urban interface areas increasing the danger to life and property should a fire occur. Areas targeted as “likely” to have a wildland fire include the Arroyo Seco/Meder Canyon, DeLaveaga, Pogonip, Moore Creek area and Arana Gulch. Increased use of these areas by residents, transient encampments with fires and young adults looking for a place to gather outside parental supervision, exacerbates the risks.

Regarding the terminology used above — likely — means that an area identified as such is one where the topography and vegetation are arranged in such a manner that it poses a threat for wildland fires. And, it should be noted, there is no statistical methodology applied to the terms likely, probability and/or high probability.

A fire threat will always exist in a wildland/urban interface area as long as vegetation, trees, down and dead fuels, structures and humans co-exist. There is a high probability that fires will occur in one or more of these areas. It is not a question of *if* they will occur but *when* will they occur.

The increasing trend of developing residences in the wildland urban interface in hazardous areas combined with recreational and transient uses of these locations have exacerbated the situation.

5.3.3 Assessing Wildfire Vulnerability: Overview

> **3.3 Assessing Vulnerability: Overview — Requirement §201.6(c)(2)(ii):**
>
> The risk assessment **shall** include a description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section.
>
> This description **shall** include an overall summary of each hazard and its impact on the community.

A OVERALL SUMMARY OF VULNERABILITY TO WILDFIRES

Santa Cruz is a compact city surrounded by greenbelt. While the majority of the city is urban, wildfires remain a threat in several canyons and in the wildland/urban interface. The areas most vulnerable to wildfires within the city are:

- Pogonip
- DeLaveaga
- Moore Creek Preserve
- Arana Gulch
- Arroyo Seco Canyon
- UCSC

Vulnerability is increased in several of these areas due to limited access and transient use. This vulnerability can be further identified with hundreds of homes located in and around these areas, in addition to neighborhood schools, a major state university, commercial facilities, and water storage tanks. Furthermore, the Climate Adaptation Plan Update (Appendix P) identifies locations of *socially vulnerable populations* with respect to wildfire hazard zones. This important and unique social vulnerability analysis enhances response strategies and actions.

The impact of wildfire on the community could have the potential for devastating effects. These impacts could be the loss of life, environmental damage, and loss of property. During the rainy season, burned-over areas are subject to mudslides and debris torrents which can impact the infrastructure of the city. This downward flow can destroy fish habitats, compromise the water quality provided to customers, and affect the flow of water into the Monterey Bay/Pacific Ocean.

5.3.4 Assessing Vulnerability: Identifying Structures

> **3.4 Assessing Vulnerability: Identifying Structures — Requirement §201.6(c)(2)(ii)(A)**:
>
> The plan **should** describe vulnerability in terms of the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard area.

A TYPES AND NUMBERS OF EXISTING BUILDINGS, FACILITIES AND INFRASTRUCTURE

Most wildland fire areas are adjacent to residential or open space areas. Only a few public buildings are immediately threatened by wildland fires. Public buildings that are in threat areas are the historic Pogonip Clubhouse, DeLaveaga Golf Club and associated buildings, schools (including university housing and educational buildings within city limits) and day care centers and some park structures. There are commercial and/or industrial structures in the threat zone (*see* Table 5-1).

5.3.5 ASSESSING VULNERABILITY: ESTIMATING POTENTIAL LOSSES

3.5 Assessing Vulnerability: Estimating Potential Losses — Requirement §201.6(c)(2)(ii)(B):

The plan **should** describe vulnerability in terms of an estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(i)(A) of this section and a description of the methodology used to prepare the estimate.

Potential Dollar Losses to Vulnerable Structures

Table 5-1 Wildfire potential loss inventory

Inventory Assets								
WILDFIRE								
	# of Parcels		**# of Structures**		**Critical Structures**		**Loss in Value$***	
Type	**Total**	**Hazard**	**Total**	**Hazard**	**Total**	**Hazard**	**Total**	**Hazard**
Residential	14,916	1,169	17,363	1,011			$9,263,773,000	$525,269,466
Commercial	1,524	8	1,310	51			$2,309,879,000	$97,371,303
Industrial	307	14	299	13			$495,671,000	$39,210,240
Religion	56	2	99	4			$168,168,000	$8,251,306
Government	217	75	30	1			$85,229,000	$1,967,884
Education	228	1	65	2			$188,840,000	$2,648,227
Agricultural	5	1	51	2			$29,942,000	$1,321,091
Total	**17,253**	**1,270**	**19,217**	**1,084**	**35**	**3**	**$12,541,502,000**	**$676,039,516**
	Community	**Hazard**						
# of People	**62,752**	**6,026**						
Date: Census American Community Survey 2015								
Total = total number of structures, residents, values within the entire community								
Hazard= number of structures, residents, values that are located within the defined hazard area								
*Loss is based on Assessment Improvement values.								
Parcel Data is from January 2017. Building Count/Total Replacement Value data is from 2014.								

B METHODOLOGY USED TO PREPARE ESTIMATE

Parcel Valuation:
Total Building Replacement Value (Building and Contents) and Building Count (Structure Count) from HAZUS-MH 3.2 Release 14.2.0. This data is from 2014.

Population:
Census population blocks were reduced to center points. If a hazard intersected a center point, that population was counted.

Calculated replacement value for average size home in the area times the number of structures for residential and for each of the commercial structures. The average home is approximately 1,800 square feet. Replacement value is approximately $220 per square foot (2012 Building Department replacement valuation) for an average replacement value of approximately $400,000.

5.3.6 ASSESSING VULNERABILITY: ANALYZING DEVELOPMENT TRENDS

3.6 Assessing Vulnerability: Analyzing Development Trends — Requirement §201.6(c)(2)(ii)(C):

The plan **should** describe vulnerability in terms of providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.

C DESCRIPTION OF LAND-USES AND DEVELOPMENT TRENDS

As was discussed previously, the City of Santa Cruz is a compact urban community that is surrounded by natural barriers to outward expansion including the Santa Cruz Mountains, the Pacific Ocean and a designated greenbelt. As the demand for housing increases there is an increased risk created in the urban rural interface.

Although Santa Cruz has over 3,000 acres of greenbelt and parkland, the City does not have the resources to adequately police and protect this area. This inadequate policing increases the frequency of illegal camping (Santa Cruz has a substantial chronic homeless population), which can result in fires in limited access and canyon areas.

5.4.0 MITIGATION STRATEGY

4.0 Mitigation Strategy: — Requirement §201.6(c)(3):

The plan **shall** include a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs and resources, and its ability to expand on and improve these existing *tools.*

The City of Santa Cruz has initiated a number of wildfire mitigation programs in the past including the DeLaveaga Vegetation Management Program and the Arroyo Seco Canyon Vegetation Management project.

Providing vegetation management crosses several departments within the City of Santa Cruz. Identified areas for vegetation management include vacant lots, streets, islands, alleys, and greenbelt areas. Some of the practices of vegetation management include frequent mowing and abatement of vegetation in these areas and these activities continue on an annual basis.

The City also continues to maintain and develop cooperative agreements with the County, UCSC (with a contract for services, not mutual aid), the California Department of Forestry and other fire protection agencies to collaboratively avoid or minimize the threat from wildland/urban interface fires. An initial increase in the number of fire units dispatched to fire-related incidents has been initiated to contain and control these situations at the initial phase of fire development.

Routine and frequent training by local and state fire jurisdictions continues. Implementation of a "reverse 911" community notification and warning system has been developed.

Building partnerships with other City departments, particularly Parks and Recreation and Police, in patrolling wildland areas, is critical to mitigation efforts when staff resources are limited. Adoption of the state fire code has addressed the regulation of building materials, construction requirements, water system supply, and code enforcement in wildland urban interface areas.

Finally, through adoption of local amendments contained in the City of Santa Cruz Municipal Code, the City is more restrictive than the state fire code when it comes to turning radius requirements of fire apparatus in access/egress issues, and a "zero-based" fire sprinkler ordinance for fire extinguishing systems.

5.4.1 Mitigation Goals

4.1 Local Hazard Mitigation Goals — Requirement §201.6(c)(3)(i):

The hazard mitigation strategy **shall** include a description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.

Wildfire Goals:

Wildfire 1 — Avoid or reduce the potential for loss of life, injury, property and economic damage to Santa Cruz from wildfire. (C-6)

Wildfire 2 — Collaborate with other County fire districts, UCSC and the California Department of Forestry in mutual fire protection efforts. (A-7)

5.4.2 Identification and Analysis of Mitigation Actions

4.2 Identification and Analysis of Mitigation Actions — Requirement §201.6(c)(3)(ii):

The mitigation strategy **shall** include a section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure.

Wildfire Mitigation Actions:

Wildfire protection mitigation strategy includes the following actions:

- Cooperative fire protection agreements with other agencies (A-7)
- Reduction of fire risk in wildland/urban interface areas through improved vegetation management and appropriate code enforcement (A-8)
- Promotion of built-in fire extinguishing and warning fire alarm systems (B-9)
- Creation of a proactive (not reactive) hazard abatement program (B-10)
- Land use planning to reduce incidence of human caused wildfire (C-4)
- Adequate staffing to meet needs of City population and development (C-5)
- Fire prevention programs in schools, institutions and commercial buildings (C-6)

CHAPTER 6: FLOODS AND ASSOCIATED COASTAL STORMS

6.3.0 Flood Risk Assessment

6.3.1 Identifying Flood Hazards

3.1 Identifying Hazards — Requirement §201.6(c)(2)(I):

The risk assessment **shall** include a description of the type, location, and extent of all natural hazards that can affect the jurisdiction.

The plan **shall** include information on previous occurrences of hazard events and on the probability of future hazard events.

Flooding and coastal storms present essentially the same risks and are frequently related types of hazards in the City of Santa Cruz. Coastal storms can cause increases in tidal elevations (called *storm surge*) wind speed and erosion as well as flooding.

A flood is a natural event for rivers and streams. Excess water from snowmelt, rainfall, or storm surge accumulates and overflows onto the banks and adjacent floodplains. Floodplains are lowlands adjacent to rivers, lakes and oceans that are subject to recurring floods. Several factors determine the severity of floods, including rainfall intensity (or other water source) and duration.

A flood occurs when a waterway receives a discharge greater than its capacity. Floods may result from intense rainfall, localized drainage problems, tsunamis or failure of flood control or water supply structures such as levees, dams or reservoirs. Floodwaters can carry large objects downstream with a force strong enough to destroy stationary structures such as bridges and break utility lines. Flood waters also saturate materials and earth resulting in the instability, collapse and destruction of structures as well as the loss of human life. The City of Santa Cruz has lost bridges and other infrastructure during previous storms.

Floods occur in relation to precipitation. Flood severity is determined by the quantity and rate at which water enters the waterway, increasing volume and velocity of water flow. The rate of surface runoff, the major component to flood severity, is influenced by the topography of the region as well as the extent to which ground soil allows for infiltration in addition to the percent of impervious surfaces. It is important to note that a stream can crest long after the precipitation has stopped.

CLIMATE ADAPTATION CONSIDERATIONS

The City of Santa Cruz Climate Adaptation Plan (CAP) considers flooding and severe coastal storms to be a considerable, potential risk to the city and its residents. Intense, increased rainfall may lead to larger flood flows. Noted in the CAP are the potential for greater storm surges, wind speeds and resultant coastal erosion. These events are predicted to occur more frequently due to climate change impacts, including those from sea level rise. In 2017, a Sea Level Rise Vulnerability Assessment was conducted, identifying the impacts from floods and coastal storms influenced by sea level rise. Flooding and coastal storm hazard zones were projected and mapped for years 2030, 2060 and 2100, quantified in terms of number of damaged or lost facilities and assets and their value, and potential effects on socially vulnerable populations.

6.3.2 Profiling Flood Hazard Events

3.2 Profiling Hazards — Requirement §201.6(c)(2)(i):

The risk assessment **shall** include a description of the type, location, and extent of all natural hazards that can affect the jurisdiction.

The plan **shall** include information on previous occurrences of hazard events and on the probability of future hazard events.

A LOCATION

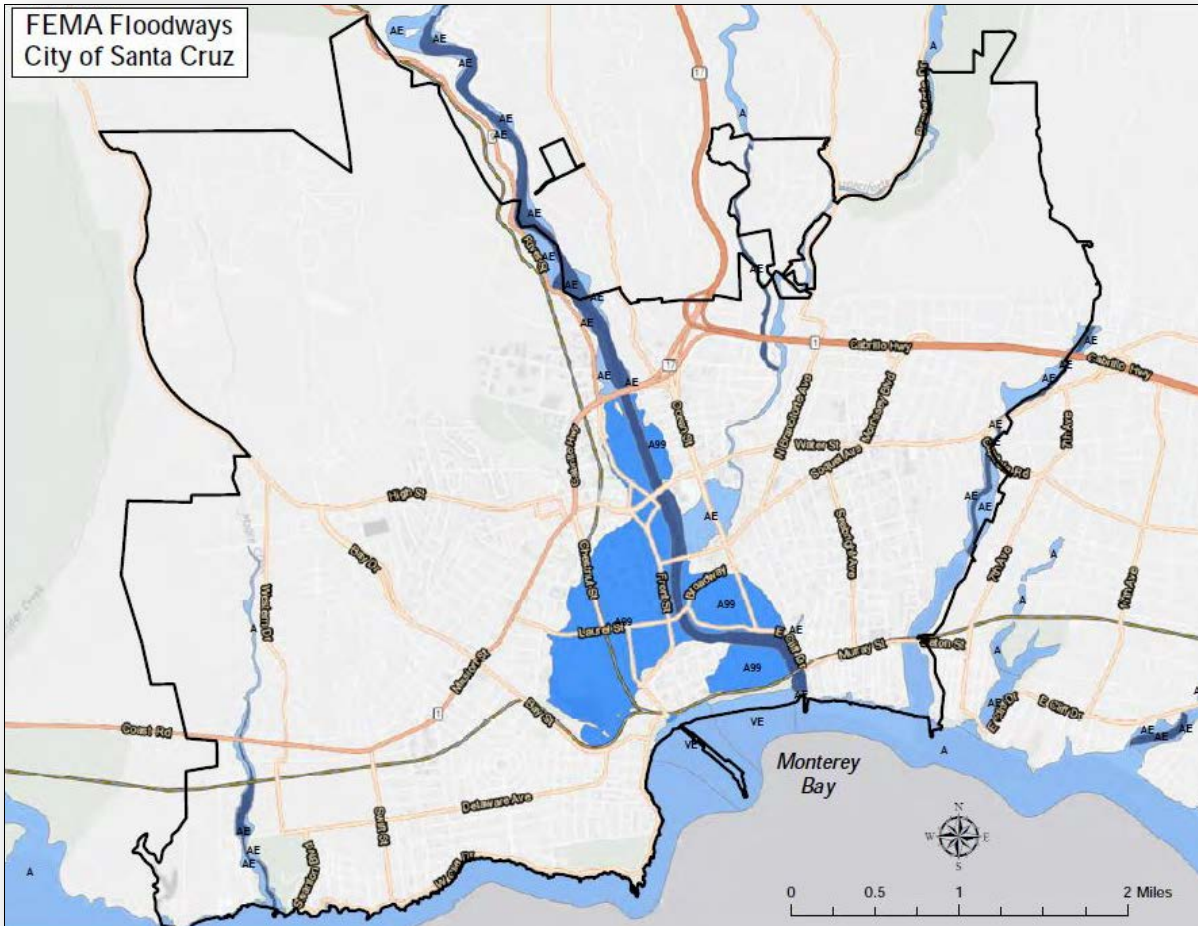


Figure 15 – FEMA Flood Map showing 100-year flood zone *Source*: FEMA (2017)

Most of the known floodplains in the United States have been mapped by FEMA, which administers the National Flood Insurance Program (NFIP) The most recent FEMA flood maps for the City of Santa Cruz can be found using this link: FEMA Flood Map Service Center. When the user is at this web page enter a property address, city and state in the page's search box and the FEMA flood map for that property in the City of Santa Cruz will be located. The next page will give the user the choice of viewing the specific FEMA flood map which includes that property or, the user can download the FEMA flood map. The flood maps shown on this site are the most current for the City of Santa Cruz.

Within the City of Santa Cruz there are several areas subject to flooding. The San Lorenzo River runs through the downtown corridor and the majority of the downtown area is in the San Lorenzo floodplain. The San Lorenzo River also runs along the edge of the Harvey West Commercial/Industrial area including the Tannery Arts Center and its associated housing.

Flooding along the coast of Santa Cruz may occur with the simultaneous occurrence of large waves and storm swells during the winter. Storm centers from the southwest produce the type of storm pattern most commonly responsible for the majority of serious coastline flooding. The strong winds combined with high tides that create storm surges are also accompanied by heavy rains. When storms occur simultaneously with high tides, flood conditions including flooding at the mouth of the San Lorenzo River are exacerbated.[16]

There are several smaller creeks in the City that are subject to periodic flooding. Flooding is a hazard on the lower reaches of Moore Creek where only shallow stream channels are present, the lower portion of Arana Gulch, north of Santa Cruz Yacht Harbor, and along portions of Branciforte and Carbonera creeks. In these areas there is minimal impact on public structures and facilities and only a few residential structures are within these flood zones.

B EXTENT: MAGNITUDE OR SEVERITY

The San Lorenzo River drains 357 sq. km (138 square miles) of the central California coast range with the annual rainfall in the Redwood forest basin averaging 120 centimeters (47in.).[17] The flood season for the San Lorenzo River extends from November to April with most of the historic floods occurring in December or January. The floods that have caused the most damage were generally of short duration and were the result of the small size and steepness of the basin.

The FEMA Community Rating System (CRS) has awarded the City of Santa Cruz a Class 7 rating. The CRS rating is an important factor in determining the magnitude of the potential for flood along the San Lorenzo River. The Community Rating System is a voluntary incentive program that is part of the National Flood Insurance Program. The CRS recognizes and encourages community floodplain management activities that exceed the minimum NFIP requirements. As a result, flood insurance premium rates are discounted to reflect the reduced flood risk resulting from community actions meeting the following three goals of the CRS:

- Reduce flood losses
- Facilitate accurate insurance rating
- Promote awareness of flood insurance

For communities participating in the CRS, flood insurance premium rates are discounted in increments of 5 percent (Community Rating System). For example, a Class 1 community would receive a 45 percent premium discount, and a Class 9 community would receive a five percent discount. A Class 10 community does not participate in the CRS and receives no discount. The CRS classes for local communities are based on 18 creditable activities organized under the following four categories:

- Public Information
- Mapping and Regulations
- Flood Damage Reduction
- Flood Preparedness

Currently, approximately 1,200 communities nationwide, including Santa Cruz, receive flood insurance premium discounts based on implementation of local mitigation, outreach, and educational activities that go well beyond minimum NFIP requirements.

The Flood Insurance Rate Map (FIRM) is an official map of a community for which the Federal Insurance and Mitigation Administration has delineated the Special Flood Hazard Area (SFHA) and the risk premium zones applicable to the community. All known areas of the city subject to natural flooding hazards have been designated and mapped by the Federal Emergency Management Agency, such as the 100 year floodplain boundaries which appear on FEMA's Flood Insurance Rate Maps and are a source for the floodplain map included in this chapter.

The City of Santa Cruz has worked to improve the flood capacity of the San Lorenzo River levees over the past twenty years. In 2002, FEMA re-designated much of the downtown and beach area from A-11 to the A-99 Flood Zone designation in recognition of the significant flood improvements resulting from the San Lorenzo River Flood Control and Environmental Restoration Project. (Flood Insurance Premium Reduction). Under the A-99 designation, new buildings and improvements are no longer mandated to meet FEMA flood construction requirements and flood insurance premiums are significantly reduced. The FEMA Community Rating System Class 7 rating for the City of Santa Cruz further reduces the National Flood Insurance Program A-99 flood insurance rates by five percent. At present the combination of the CRS Class 7 rating and the A-99 designation reduces flood insurance by 45%. The City of Santa Cruz is one of the 5.5% of communities in the FEMA National Flood Protection Program who participate in the CRS Program.

Despite recent flood control projects and improved flood rating in much of the downtown and beach area, the risk of flooding is still a concern to the city. While the levee project has resulted in a more flood-resistant downtown, floods may still occur. The levee project did not impact areas along the San Lorenzo River above the Highway 1 Bridge (including the Tannery Arts Center and the associated live-work studios) where flooding is still a significant risk and construction requirements must still address the risk of floods.

C PREVIOUS OCCURRENCES

The City of Santa Cruz is located around the floodplain of the San Lorenzo River and has been subject to floods throughout recorded history from the time the Mission was first built in 1793 to the "Christmas Flood" on December 22, 1955. Eighteen floods, eight of which have been considered severe, have occurred over the last ten decades in Santa Cruz. As discussed above, the San Lorenzo River Levee Project has significantly reduced the risk of flooding in the downtown area. However, the downtown and beach areas are still designated as floodplains.

During the last LHMP review period there were no repetitive loss properties in the City of Santa Cruz and at present there are no repetitive loss properties.

Historical Record of Severe Floods of Santa Cruz 1862-2006

- **January 11, 1862 —** Land consumed and buildings along river banks destroyed. "Bulkhead" at Bulkhead Street was built after this flood to prevent water from reaching Main and Willow Streets (now Front Street and Pacific Avenue).
- **December 23, 1871 —** Bridges built after 1862 flood across San Lorenzo damaged.

- **January 25, 1890 —** River level highest recorded to this date. A debris dam collected against pilings behind the rail bridge at the mouth of the river. With the failure of the rail bridge, flood levels dropped dramatically. The practice of using pilings to span the river was stopped after this flood.
- **January 4, 1895 —** Levels exceeded the Bulkhead and caused basement, yard and lot flooding in the downtown area.
- **March 27, 1907 —** This flood had water levels higher than previous floods. Flood control discussion increased**.**
- **February 27, 1940 —** Very severe flooding**.**
- **February 9, 1941 —** This was the third flood to hit in four years. Flood control becomes a focus.
- **December 22, 1955 —** Highest historic flood in the area, filling 410 acres of lowlands outside the river channel including the downtown. Ninety percent of the damage in the county occurred within the City of Santa Cruz and cost the City millions of dollars.
- **January 4, 1982 —** Water rose to within two feet of the top of the levees along the San Lorenzo River and flooding occurred both north and south of the freeway along Carbonera and Branciforte Creeks in the Twin Creeks and Brookside Glen developments. This approximately 30-year event also reached the top of the concrete portion of Branciforte Creek at Market Street and overflowed. The older part of the Soquel Avenue bridge, built in 1923, collapsed.
- **February 1995 Storms —** Santa Cruz was one of 57 counties declared disaster areas due to flooding.
- **January 1997 —** Santa Cruz was one of 48 counties declared disaster areas due to severe storms and flooding.
- **February 1998 El Niño —** Santa Cruz was one of a number of counties declared disaster areas due to El Niño.
- **April 2006 —** Severe storms and flooding. Santa Cruz was one of several counties to be declared a disaster area. FEMA Disaster 1646 (June 5, 2006)
- **March 2011 —** Severe storm damage. Santa Cruz County was among 19 counties proclaimed by the Governor as in a state of emergency due to storms between March 15 and March 27.
- **January/February 2017 —** Emergency Declarations due to Winter Storms

Emergency Declarations — Winter Storms: 2017

City Council Resolution	Date	Action
NS-29,190	**Jan 7, 2017**	• Ratifying Proclamation declaring a local emergency due to January 7, 2017 storms • Requesting Governor's Proclamation of state of emergency
NS-29,197	**Feb 6, 2017**	• Ratifying Proclamation declaring the existence of a local emergency due to the severe weather and rainstorms beginning on February 6, 2017 • Requesting Governor's Proclamation of state of emergency
NS-29, 198	**Feb 28, 2017**	• Affirming existence of continued emergency due to January 7, 2017 storms (original Resolution NS-29,190)
NS-29-212	**Mar 28, 2017**	• Terminating Local Emergency due to January 7, 2017 Storms • Rescinding Resolutions NS-29,190 and NS-29,198

D PROBABILITY OF FUTURE EVENTS

Significant storms and associated damage from flooding strike the Monterey Bay communities with a frequency of one large storm every three to four years. A 100-year flood has a one percent probability of occurring in any given year and, while considered to be a severe flood, it still has a reasonable possibility of regular occurrence. For the purposes of the protection of property, life and safety, floods of other magnitudes and occurrence intervals should also be considered in mitigation efforts.

Floods and flooding are gauged by their size (width and depth of the affected area) and the probability of occurrence. The width and depth of the floodplain area is computed using mathematical models of precipitation, slope, runoff, soil type and cross-section. Flood depths are calculated at intervals along a stream or channel corridor and then mapped and interpolated between sections. This results in the floodplain map.

The probability of occurrence is expressed in a percentage of the chance of a flood of a specific extent occurring in any given year. The most widely adopted design and regulatory standard for floods in the United States is the 1% annual chance flood, and this is the standard formally adopted by FEMA. The "one percent" annual flood is also commonly referred to as the "100-year flood," leading to the misconception that it should occur only once every 100 years. In fact, a 100-year flood may occur in any year, regardless of the time that has passed since the last one. It is the probability that smaller floods occur more often than larger floods that compels the percentage.

Table 6-1 Flood Probability Terms

Flood Occurrence Intervals	Percent Chance of Occurrence Annually
10 years	10.0%
50 years	2.0%
100 years	1.0%
500 years	0.2%

6.3.3 Assessing Flood Vulnerability: Overview

> **3.3 Assessing Vulnerability: Overview — Requirement §201.6(c)(2)(ii):**
>
> The risk assessment **shall** include a description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section.
>
> This description **shall** include an overall summary of each hazard and its impact on the community.

A OVERALL SUMMARY OF VULNERABILITY TO FLOODS

The City of Santa Cruz has worked for the past twenty years to improve the flood capacity of the San Lorenzo River levees. Work is now complete on the final phase of the Army Corps of Engineers San Lorenzo River Flood Control Project and FEMA has recognized the increased flood protection that the new higher levees provide by granting the A-99 flood zone designation. The downtown and the area along the river are still in a 100-year floodplain. Coastal storms contribute to the risk of flooding in this area.

The river bank north of the Highway 1 bridge (near the new Tannery Arts site) was not part of the Army Corps of Engineers Project and this area is subject to flooding as are some low lying areas near creeks and streams. While the most vulnerable areas along the river, particularly the downtown corridor, are now less vulnerable, they are still at risk during a 100-year storm, until the fifth phase of the Corps' project is completed.

6.3.4 Assessing Flood Vulnerability: Identifying Structures

> **3.4 Assessing Vulnerability: Identifying Structures — Requirement §201.6(c)(2)(ii)(A):**
>
> The plan **should** describe vulnerability in terms of the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard area.

Types and Numbers of Existing Buildings, Facilities and Infrastructure

Much of the downtown and beach areas are in the 100-year floodplain. The backup Emergency Operations Center (Police Department) as well as most of the City and County government buildings are in the floodplain. The floodplain includes the following:

- 2,232 Structures (2,270 parcels)
- The Central Fire Station
- The Police Station
- City Hall campus
- Coast Pump Station
- Lifeguard and Marine Safety Headquarters
- The County Government Center
- 41 schools and day care centers
- Tait Wells

6.3.5 Assessing Vulnerability: Estimating Potential Losses

3.5 Assessing Vulnerability: Estimating Potential Losses — Requirement §201.6(c)(2)(ii)(B):

The plan **should** describe vulnerability in terms of an estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(i)(A) of this section and a description of the methodology used to prepare the estimate.

A POTENTIAL DOLLAR LOSSES TO VULNERABLE STRUCTURES

Table 6-2 Flood Potential Loss Inventory

Inventory Assets								
100 YEAR FLOOD								
	# of Parcels		**# of Structures**		**Critical Structures**		**Loss in Value$***	
Type	**Total**	**Hazard**	**Total**	**Hazard**	**Total**	**Hazard**	**Total**	**Hazard**
Residential	14,916	1,592	17,363	2,046			$9,263,773,000	$1,357,848,262
Commercial	1,524	667	1,310	300			$2,309,879,000	$740,573,283
Industrial	307	9	299	33			$495,671,000	$42,732,525
Religion	56	9	99	18			$168,168,000	$33,487,566
Government	217	128	30	11			$85,229,000	$31,047,977
Agricultural	5	2	51	6			$29,942,000	$3,638,295
Education	228	4	65	8			$188,840,000	$37,000,587
Total	**17,253**	**2,411**	**19,217**	**2,422**	**35**	**18**	**$12,541,502,000**	**$2,246,328,493**
# of People	**62,752**	**14,464**						
Date: Census American Community Survey 2015								
Total = total number of structures, residents, values within the entire community								
*Building Count/Total Replacement Value data is from 2014.								
Parcel Data is from January 2017								

B METHODOLOGY USED TO PREPARE ESTIMATE

Parcel Valuation:
Total Building Replacement Value (Building and Contents) and Building Count (Structure Count) from HAZUS-MH 3.2 Release 14.2.0. This data is from 2014.

Population:
Census population blocks were reduced to center points. If a hazard intersected a center point, that population was counted.

Flood Analysis:
Since FEMA flood data is mapped on the federal level, the data is extremely coarse in horizontal accuracy. The data was not meant to be measured against parcel level information and therefore is a rough estimate of damage and loss.

Estimating flood losses is an established process. If a 100-year flood occurred in Santa Cruz, meaning the flood that had a 1% chance of occurring in any given year, it would impact approximately 2,200 structures to various degrees. This was determined by intersecting the city's database of structures with the FEMA developed maps of the 100-year floodplain.

Santa Cruz structures in the floodplain vary in construction, size and materials, ranging from single family homes to multi-family to commercial. The downtown of the City of Santa Cruz lies almost entirely within the 100-year floodplain. Many structures in this area are multi-story.

The primary purpose of the San Lorenzo Levee Project was to reduce flood damage and loss within the City of Santa Cruz 100-year floodplain. According to the Federal Emergency Management Agency, the December 1955 flood caused over $40 million in damage. The U.S. Army Corps of Engineers estimated that a 100-year flood in the downtown area in 2002 would have caused $86 million in damage.[18]

6.3.6 ASSESSING VULNERABILITY: ANALYZING DEVELOPMENT TRENDS

3.6 Assessing Vulnerability: Analyzing Development Trends — Requirement §201.6(c)(2)(ii)(C):

The plan **should** describe vulnerability in terms of providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.

A DESCRIPTION OF LAND USES AND DEVELOPMENT TRENDS

As was described previously, the City of Santa Cruz is a compact urban community that is surrounded by natural barriers to outward expansion including the Santa Cruz Mountains, the

Pacific Ocean and a designated greenbelt. In Santa Cruz, most development is now infill or reuse development.[19]

The beach and downtown commercial areas are in the 100-year floodplain. Increasing residential density and mixed use development continue in the downtown core. The Tannery Arts project including a residential component is located in a floodplain next to the San Lorenzo River above the levee project area.

The City is required by Association of Monterey Bay Area Governments (AMBAG) to zone for its share of housing. Two of the three available properties with the highest density zoning are located in the floodplain.

6.4.0 Mitigation Strategy

4.0 Mitigation Strategy: — Requirement §201.6(c)(3):

The plan **shall** include a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs and resources, and its ability to expand on and improve these existing tools.

How the City of Santa Cruz will Continue Compliance with NFIP Requirements

Background:

In 1986 the City of Santa Cruz entered the FEMA National Flood Insurance Program and has since enforced the FEMA building regulations in its FEMA Special Flood Hazard Area (SFHA). In 2002 FEMA designated much of the city's SFHAs as an "A-99" Flood Zone (A-99 is defined as: "Areas with a 1% annual chance of flooding that will be protected by a Federal flood control system where construction has reached specified legal requirements. No depths or base flood elevations are shown within these zones." [Source: Definitions of FEMA Flood Zone Designations]).

An A-99 rating is given in recognition of the progress made by the City and the U.S. Army Corps of Engineers on the improvements to the city's existing flood control levees. It has been the goal of the City and the U.S. Army Corps of Engineers to improve the levee system over time so that it has the capacity to handle a 100 year flood and gain FEMA Certification. Designing and building a flood control project is a long term effort requiring millions of dollars and years of time.

In past years the City was an approved participant in the FEMA Cooperating Technical Partner Program (CTP). Through this program the City of Santa Cruz was one of the earlier adopters of the new FEMA digital maps.

Current Compliance Efforts:

Each year the City certifies to FEMA that it is making progress with the Corps of Engineers on developing plans and improvements to eventually meet the 100 year FEMA certification requirements.

Another FEMA program that the City has been an active participant in is the Community Rating System (CRS). Currently, the City of Santa Cruz is a CRS "Class 7" community. The City began its participation in the CRS program in 1999 and each year submits the required certifications. Most recently, the City completed its Five Year Review Cycle utilizing the new CRS 2017 Manual. This review process was very comprehensive and required a significant amount of City staff resources.

Ongoing and Future Compliance Planning:

The City plans on continuing its participation in the CRS program as a way to help reduce flood insurance premiums for Santa Cruz residents and improve its flood responsiveness.

As to future commitments, due to the interrelated nature of the FEMA and U.S. Army Corps of Engineers, the City plans on continuing our active engagement with both agencies. Given the timeframe required for improving flood protection, this process will be measured in years and will require a continuing commitment of future City resources.

Through its past work with FEMA and the U.S. Army Corps of Engineers the City has gained an understanding of their processes and they have a clear understanding of the City's commitment to improving its community's flood protection.

The City of Santa Cruz addresses land use within the flood plain in the General Plan as well as actively enforcing building and zoning codes, and other land use regulations concerning development within the 100-year flood plain.

The City of Santa Cruz has worked to improve the flood capacity of the San Lorenzo River levees over the past twenty years. As noted above, in 2002, FEMA re-designated much of the downtown and beach area from A-11 to the A-99 Flood Zone designation in recognition of the significant flood improvements resulting from the San Lorenzo River Flood Control and Environmental Restoration Project.

And, again, as noted in the future compliance statements above, the City will continue to work with FEMA and the Army Corps of Engineers to minimize impacts of flooding in Santa Cruz. The City will also work to maintain or improve its CRS rating.

6.4.1 Mitigation Goals

4.1 Local Hazard Mitigation Goals — Requirement §201.6(c)(3)(i):

The hazard mitigation strategy **shall** include a description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.

The City of Santa Cruz has developed several flood hazard mitigation goals to create a more flood resistant community.

Flood Goals:

Flood 1 — Avoid or reduce the potential for life loss, property and economic damage from flooding and severe coastal storms.

Flood 2 — Facilitate accurate insurance ratings through participation in FEMA's Community Rating System.

Flood 3 — Promote public awareness of flood hazards, mitigation measures and flood insurance.

6.4.2 Identification and Analysis of Mitigation Actions

4.2 Identification and Analysis of Mitigation Actions — Requirement §201.6(c)(3)(ii):

The mitigation strategy **shall** include a section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure.

Flood Mitigation Actions:

The City participates in a number of ongoing mitigation actions to avoid or reduce the threats of flood. These measures are listed in this Plan in Part 4, Mitigation Strategy. Actions include:

- Participation with other agencies in an early warning system for evacuation of areas susceptible to flooding, tsunami or dam failure. (B-4)
- Regulations on development and alteration of flood plains, stream channels and protective barriers that accommodate overflow are in place. (B-5)
- Encouragement of property owners, potential buyers and residents living in flood plains and coastal inundation areas to participate in Federal Flood Insurance Program. (B-6)

- The City has adopted the Creeks and Wetlands Management Plan (February 28, 2006; certified by California Coastal Commission May 9, 2008) which provides guidelines including measures to reduce creek flooding. (B-7)
- The City is continually working to rehabilitate the city's culverts and storm drainage system to reduce flooding caused by inadequate storm drainage. (B-8)
- Annual flood control maintenance on the San Lorenzo River by the Public Works Department as required by the U.S. Army Corps of Engineers. Work consists primarily of managing in-stream riparian vegetation to encourage geomorphic form and function. The vegetation management is identified in the San Lorenzo Urban River Plan and requires vegetated buffer zones to be generally maintained at ten feet at the toe of the levees and five feet along the wetted edge of the river. Vegetation management is required in order for winter flows not to exceed the design capacity of the river and to promote scouring of the river. The maintenance generally takes about four to five weeks each year to complete. (B-12)

CHAPTER 7: DROUGHT

7.3.0 Drought Risk Assessment

7.3.1 Identifying Drought Hazards

3.1 Identifying Hazards — Requirement §201.6(c)(2)(i): The risk assessment **shall** include a description of the type, location, and extent of all natural hazards that can affect the jurisdiction.

From the City of Santa Cruz *Water Shortage Contingency Plan* (2009):

> Drought is a normal, naturally occurring but unpredictable climatic phenomenon of varying frequency, duration and severity. Droughts differ from other natural hazards in that they are not distinct weather events, like floods, hurricanes, or tornados. They may have a slow onset, persist and evolve over a period of years, affect a large spatial region, but cause little structural damage. The most difficult aspect of a drought is that no one can tell how long it will last.
>
> Five degrees of drought intensity are recognized nationally, including abnormally dry, moderate, severe, extreme, and exceptional.
>
> The California Department of Water Resources describes drought as:
>
> > *"A deficiency of precipitation over an extended period of time resulting in a water shortage for some activity, group, or environmental sector."*
>
> A water shortage, on the other hand, occurs when a particular utility's water supply is insufficient to meet its customers' ordinary drinking water needs. Besides weather conditions, there are a number of factors that affect water supply availability, including:
>
> - Source yield and reliability
> - Infrastructure capacity and operating constraints
> - Access to alternative sources
> - System demand characteristics

The City of Santa Cruz relies predominantly on local surface water sources, including coastal streams and the San Lorenzo River, for most of its annual water supply needs. The yield of these sources in any given year is directly related to the amount of rainfall received and runoff generated during the winter season. Water stored in Loch Lomond Reservoir is used mainly in the summer and fall seasons when the flows in the coast and river sources decline and additional supply is needed to meet dry season demands.

The problem of supply reliability stems primarily from two factors: the wide range in the yield of surface water sources from year to year and limited storage capacity. No water is purchased from state or federal sources or imported to the region from outside the Santa Cruz area.

Every year in late January the City prepares an initial "water supply outlook" that evaluates winter water conditions, including rainfall, stream flow, reservoir storage, and cumulative runoff, and issues a report discussing water conditions and the need, if any, for water shortage actions for the dry season ahead. A final water supply outlook is issued in late March or early April. If needed, a recommendation to declare a water shortage is brought to the City Council at a public hearing for its consideration and adoption.

CLIMATE ADAPTATION CONSIDERATIONS

Santa Cruz' water supply reliability issue is the result of having only a marginally adequate amount of storage to serve demand during dry and critically years when the system's reservoir does not fill completely. Both expected requirements for fish flow releases and anticipated impacts of climate change will turn a marginally inadequate problem into a seriously inadequate one in the coming years.

7.3.2 Profiling Drought Hazard Events

3.2 Profiling Hazards — Requirement §201.6(c)(2)(i):

The risk assessment **shall** include a description of the type, location, and extent of all natural hazards that can affect the jurisdiction.

The plan **shall** include information on previous occurrences of hazard events and on the probability of future hazard events.

A LOCATION

The City of Santa Cruz is located on the central coast of California along the northern shore of Monterey Bay. The Santa Cruz water system provides water service to an area approximately twenty square miles in size, including the entire City of Santa Cruz, adjoining unincorporated areas of Santa Cruz County, a small part of the City of Capitola, and coastal agricultural areas north of the city. A map of the water system coverage area, excluding the north coast, is included Figure 16 (*below*).

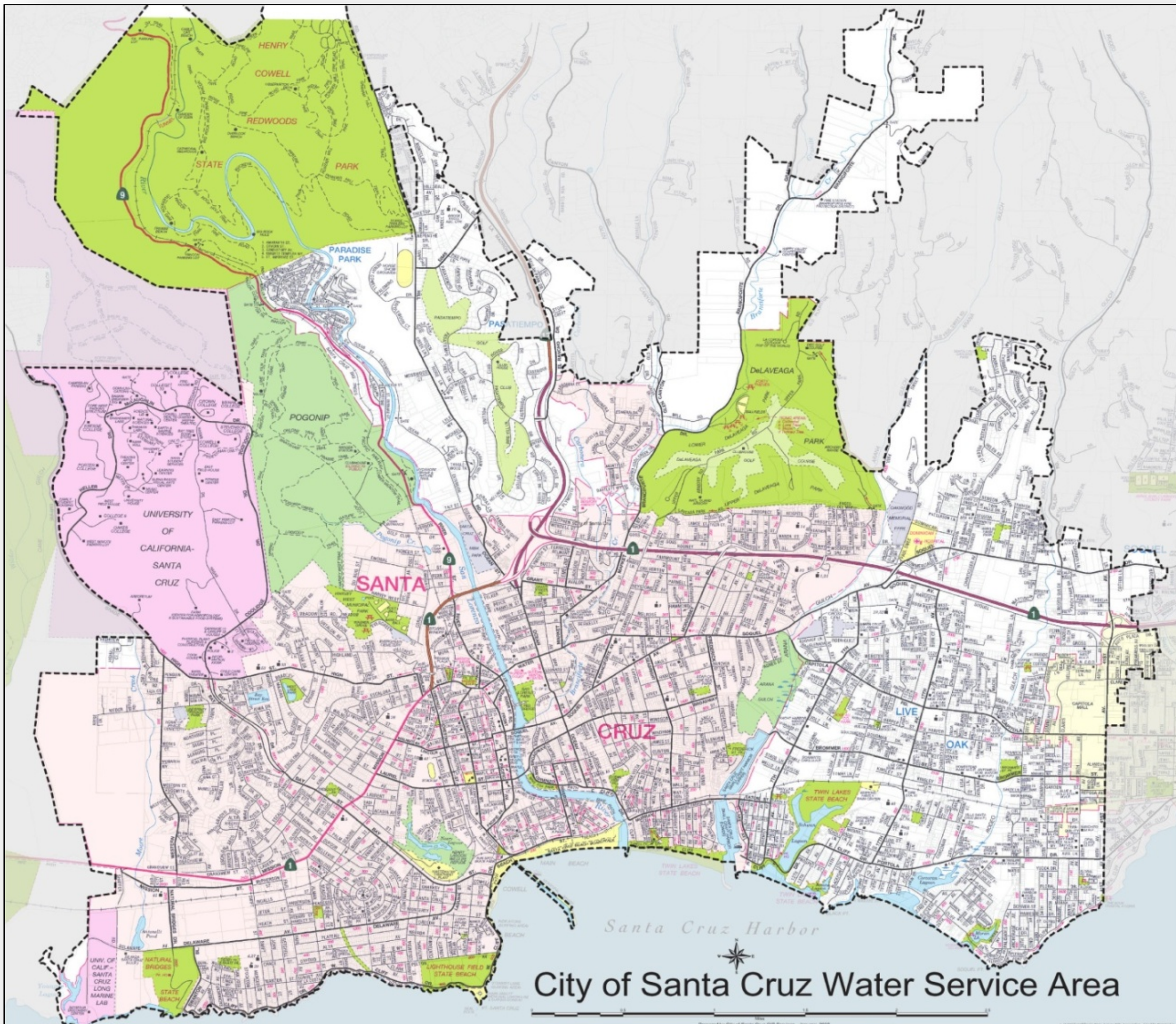


Figure 16 – Water Service Area *Source*: City of Santa Cruz (2017)

The geographic scale that is affected by major drought, however, is much larger that the City's water service area, covering parts of or all of the state of California and the western United States. At the height of the most recent drought, in late 2015, almost half the state was classified as being in a state of exceptional drought. The large geographic extent means many other water suppliers are facing the same problem at the same time, media coverage is extensive, and the state actively coordinates its response with local suppliers.

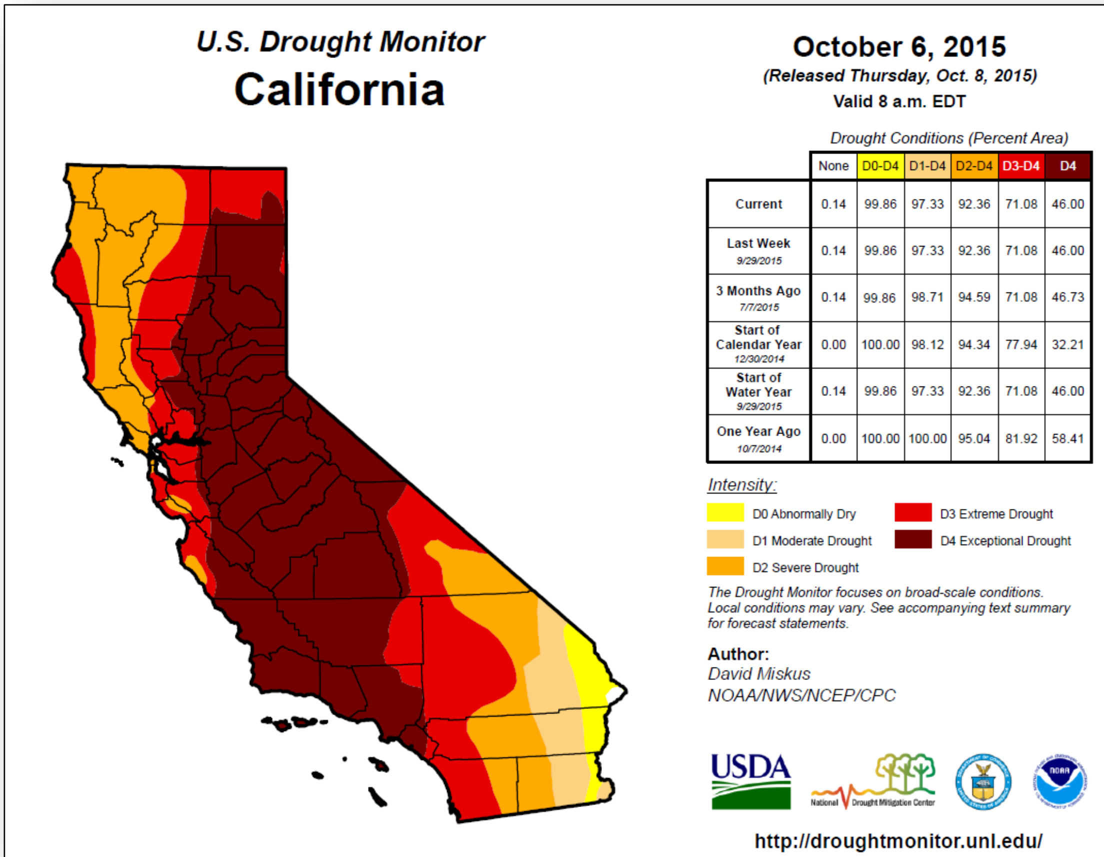


Figure 17 – US Drought Monitor, late 2015 *Source*: See map legend and source, above (2015)

B EXTENT: MAGNITUDE OR SEVERITY

As indicated in Figure 17 (*above*), 5 degrees of drought intensity area recognized nationally, including abnormally dry, moderate, severe, extreme, and exceptional.

The Water Department uses a local water year classification system to characterize the City's overall annual water supply condition. Under this classification system, the water year beginning October 1 is designated as one of four types — **Wet**, **Normal**, **Dry**, or **Critically Dry** — depending on the total annual discharge of the San Lorenzo River, measured at the stream gage in Felton, and expressed in acre-feet. As can be seen from the chart below, there have been at least six multi-year dry periods since 1921, including the most recent drought extending from 2012 to 2015 (Figure 18).

In normal and wet years when rainfall and runoff are abundant, base flows in the coast and river sources are restored by winter rains, and Loch Lomond Reservoir is typically replenished to full capacity with runoff from the Newell Creek watershed.

The water system, however, is highly vulnerable to shortage in drought years when the San Lorenzo River and coast stream sources run low. In single dry or below average years, the system relies more heavily on water stored in Loch Lomond to satisfy demand, which draws down the reservoir level lower than usual and depletes available storage.

In multi-year or critical drought conditions, the combination of very low surface flows in the coast and river sources and depleted storage in Loch Lomond reservoir reduces available supply to a level which cannot support average dry season demands. Compounding the situation is the need to maintain instream flow releases to fish habitat and reserve some amount of storage in Loch Lomond in the event drought conditions continue into the following year.

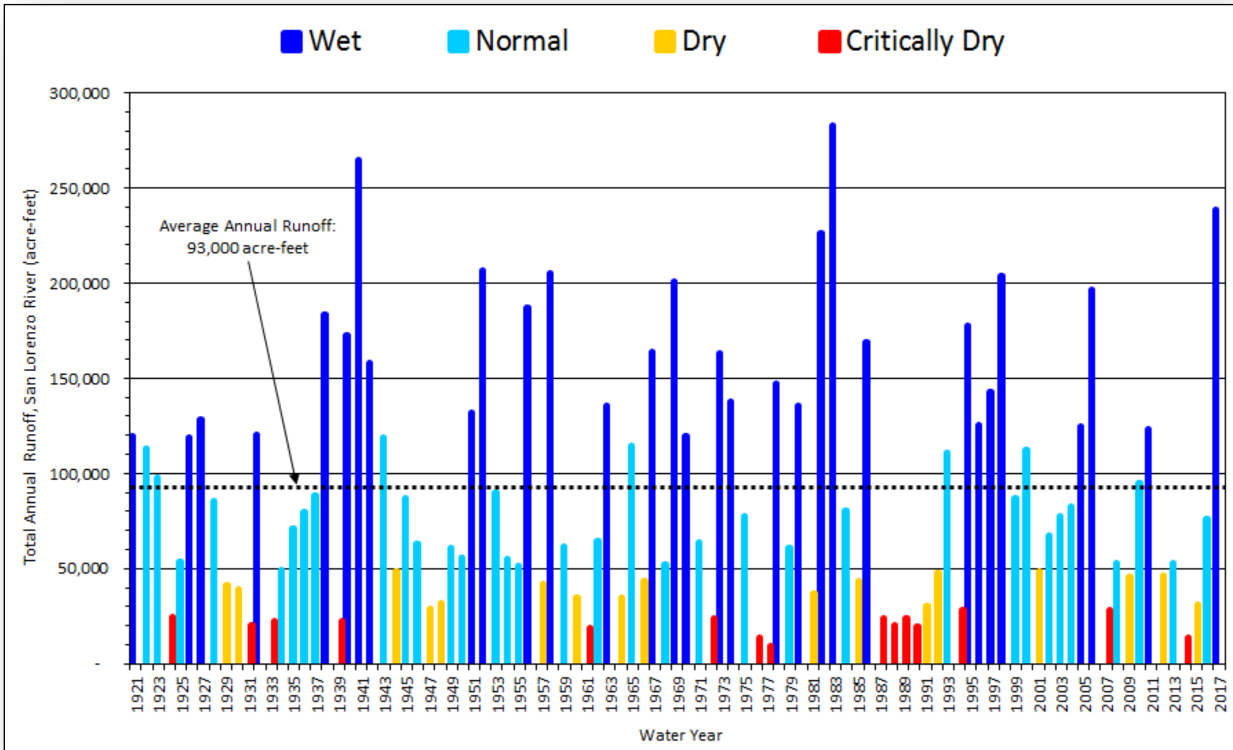


Figure 18 – Water Year Classification is based on Total Annual Runoff in the San Lorenzo River (acre feet)
Source: 2015 Urban Water Management Plan
City of Santa Cruz, CA • Water Department

Single Dry Year:

The total water supply estimated to be available to the City in single dry years like 2014 is 2,600 to 2,700 million gallons (mg) or about 15 to 20 percent less than is available in normal years. Table 7-1 (*below*) shows that there would be a fairly significant supply deficit in single dry years under projected demand conditions, which will actually decrease as demand declines over time.

Table 7-1 Single Dry Year Supply and Demand Assessment (million gallons/year)

	2020	2025	2030	2035
Supply Totals	2,619	2,658	2,692	2,692
Demand Totals	3,327	3,225	3,205	3,220
Difference	(708)	(567)	(513)	(528)

Source: 2015 Urban Water Management Plan

Multiple Dry Years:

In an extreme two-year drought similar to the 1976–77 event, the estimated water supply available to the City in the second year of that event is between 1,900 and 2,000 mg or about 40% less on an annual basis than is available in normal water years. Table 7-2 below shows that there would be a severe water supply shortage of about 1,200 to 1,400 mg under projected demand conditions in the second year of a multiple year drought, which will grow slightly less worse as demand declines over time.

The magnitude of the shortfall is greatest during the peak season between April and October, since these are the months of the year that would be most affected by a supply shortage. Under such conditions, the water system would be barely able to meet half of normal requirements of the water service area.

Table 7-2 Multiple Dry Year Supply and Demand Assessment (million gallons/year)

	2020	2025	2030	2035
Supply Totals	1,918	1,942	1,968	1,969
Demand Totals	3,327	3,225	3,205	3,220
Difference	(1,409)	(1,283)	(1,237)	(1,251)

Source: 2015 Urban Water Management Plan

C PREVIOUS OCCURRENCES

The City has responded to major, multi-year droughts on three separate occasions since the 1970s. These include the 1976–77, 1987–1992, and 2012–2015 droughts. In all three events, the City had to declare a water shortage emergency and institute mandatory water restrictions and rationing. In the most recent drought, the City declared a Stage 1 Water Shortage Alert in 2012 and 2013, and a Stage 3 Water Shortage Emergency in both 2014 and 2015.

D PROBABILITY OF FUTURE EVENTS

The City recently performed an analysis of its challenge to meet current and future demand during the Water Supply Advisory Committee (WSAC) process. The key conclusion of that analysis, assuming that future hydrology looks like the historic record and, assuming expected fish flow requirements, is that the City faces some likelihood of water shortage in approximately one out over every five years. In order to properly evaluate solutions, WSAC determined a 1.2-billion gallon projected worst-year gap between peak season available supply and demand during an extended drought.

To address the problem the City accepted the supply augmentation strategy and implementation plan developed by the WSAC and adopted by City Council under the 2015 Urban Water Management Plan. The implementation plan elements included in the current plan are:

- Expanded conservation programming
- Regional aquifer recharge by passive or active process
- Alternatives for recycled water use, and
- An updated option for desalination

Several milestones and decision points are built into the plan based on the target for supply sufficiency by 2025. Should the City be unable to overcome the supply-demand gap under the current plan, the community will be exposed to a much greater risk of shortages and be subject to higher rates of curtailment.

7.3.3 Assessing Vulnerability: Overview

3.3 Assessing Vulnerability: Overview — Requirement §201.6(c)(2)(ii):

The risk assessment **shall** include a description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section.

This description **shall** include an overall summary of each hazard and its impact on the community.

A OVERALL SUMMARY OF VULNERABILITY TO DROUGHT

The City water service area is a physically and geographically isolated, self-reliant system. The City does not now, nor does it plan to, purchase or import water either from outside the Central Coast Hydrologic Region or outside the county. The system relies entirely on rainfall, surface runoff, and groundwater infiltration occurring within the watersheds located within Santa Cruz County. Due to its isolation and reliance on surface water supplies, the City is highly vulnerable to shortage in drought years when the San Lorenzo River and coast sources run low.

As described further below, the City is actively working to reduce its water demand through water conservation and increase its supply to increase water supply reliability. The Water Shortage Contingency Plan would be invoked again if the City were to face another shortage before additional supplies are brought online.

7.3.4 Assessing Vulnerability: Identifying Structures

3.4 Assessing Vulnerability: Identifying Structures — Requirement §201.6(c)(2)(ii)(A): The plan **should** describe vulnerability in terms of the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard area.

A TYPES AND NUMBERS OF EXISTING BUILDINGS, FACILITIES AND INFRASTRUCTURE

Structures and facilities are not vulnerable to drought. Physical losses would probably be limited to public and private landscaping. However, the impacts to the landscaping which occur as the result of severe drought conditions also increase the risk of wildfire and subsequent damage to structures as a result.

7.3.5 Assessing Vulnerability: Estimating Potential Losses

3.5 Assessing Vulnerability: Estimating Potential Losses — Requirement §201.6(c)(2)(ii)(B): The plan **should** describe vulnerability in terms of an estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(i)(A) of this section and a description of the methodology used to prepare the estimate.

A POTENTIAL DOLLAR LOSSES TO VULNERABLE STRUCTURES

While structures are not at risk, significant economic losses may occur as a result of severe rationing during a water shortage. One of the City's major industries is tourism. The vulnerability to drought (or more specifically water shortages as a result of drought) reaches its peak during the summer tourism season.

Restaurants, hotels, amusement parks and other tourist serving businesses would all be at risk of closing or severe restrictions during a critical drought. This is critical to funding ongoing City services because of the City's reliance on the Transient Occupancy Tax (TOT). Other industries such as agriculture, food processing, contractors, landscapers, nurseries, golf courses, public landscaping and school grounds would all experience economic costs and losses, and other water dependent businesses would suffer economic damages. These economic losses have not been calculated.

B METHODOLOGY USED TO PREPARE ESTIMATE

While potential economic losses have been considered they have not been calculated; therefore, there is no loss estimate.

7.3.6 ASSESSING VULNERABILITY: ANALYZING DEVELOPMENT TRENDS

3.6 Assessing Vulnerability: Analyzing Development Trends — Requirement §201.6(c)(2)(ii)(C):

The plan **should** describe vulnerability in terms of providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.

A DESCRIPTION OF LAND-USES AND DEVELOPMENT TRENDS

Santa Cruz is a compact urban City surrounded by mountains, greenbelt and the Pacific Ocean. The size of the water service area is fixed. It has remained constant over time due to a policy prohibiting water main extensions to unserved areas, and the acquisition of open space lands which creates a greenbelt around the City that serves to inhibit urban sprawl. Accordingly, any growth and redevelopment that does happen going forward is expected to be concentrated within the confines of the existing service area boundary.

Within the City of Santa Cruz, only a small amount of land remains undeveloped. The same is true in the parts of the County and City of Capitola served by the City. Because of the relative scarcity of raw land, the majority of future growth in the area is likely to be achieved through redevelopment, remodeling, increased density on underutilized land, and infill development in the urban core and along major transportation corridors, along with new construction on the little amount of vacant land remaining.

The City of Santa Cruz water system currently serves approximately 96,000 people and is anticipated to grow to 112,000 by 2035. This number includes estimated additional University growth. According to utility billing records, there are some 37,003 housing units within the City's water service area. Additional growth will not increase vulnerability due to the actions and recommendations to be pursued as found in the City's Water Supply Advisory Committee.

7.4.0 Mitigation Strategy

4.0 Mitigation Strategy: — Requirement §201.6(c)(3): The plan **shall** include a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs and resources, and its ability to expand on and improve these existing tools.

The 2015 Urban Water Management Plan (UWMP) that includes the Water Supply Advisory Committee Final Report on Agreements and Recommendations and the Water Shortage Contingency Plan was adopted to overcome drought impacts.

Since the adoption of the UWMP, a Water Supply Augmentation Strategy was developed and is currently being implemented by following a Work Plan that includes the approved elements and adaptive management strategy from the WSAC process. The following elements are included in the Work Plan:

Water Conservation

In addition to the existing conservation programs the WSAC recommends looking at new programs, such as increased rebates and better management of peak season demand. The goal of these additional programs would be to further reduce demand by 200 to 250 million gallons per year by 2035, with a particular focus on producing savings during the peak water demand season.

Groundwater Recharge by "In Lieu" Water Transfers or Aquifer Storage and Recovery

Using in lieu water transfers, available winter flows would be delivered to Soquel Creek Water District and/or Scotts Valley Water District customers, thus allowing reduced pumping from these regional aquifers and enabling the aquifer to passively rest and recharge. Using Aquifer Storage and Recover (ASR), available winter flows would be injected into aquifers thereby actively recharging aquifers. A portion of the water delivered using In Lieu or ASR would be effectively banked in the aquifers to be extracted and available to the City when needed in future dry years.

Advanced-treated recycled water, with desalination as a back-up

In the event the groundwater storage strategies prove insufficient to meet the plan's goals, these two options would be developed as supplemental or replacement supply.

The overall goal of the Work Plan is to overcome the known worst-year supply gap of 1.2 billion gallons per year through a combination of enhanced conservation programs and increased water storage options. If needed, the Work Plan includes alternatives for supply augmentation either with recycled water or seawater desalination. The Work Plan was developed consistent with an objective for significant improvement to the sufficiency and reliability of the water supply in 2025 and several milestones and decision points are built into the change management framework to react as conditions, information, and technology changes occur.

Until such time that the City has increased the reliability through conservation and storage options, the mitigation measures outlined in the Water Shortage Contingency Plan would be implemented in the event of a future drought. The City's Water Shortage Contingency Plan describes the conditions which constitute a water shortage and provides guidelines, actions, and procedures for managing water supply and demands during a declared water shortage. The overarching goals of this plan are as follows:

1. To conserve the water supply of the City for the greatest public benefit;
2. To mitigate the effects of a water supply shortage on public health and safety, economic activity, and customer lifestyle, and
3. To budget water use so that a reliable and sustainable minimum supply will be available for the most essential purposes for the entire duration of the water shortage.

This plan uses a staged approach that classifies a shortage event into one of five levels spanning a range from less than 5 percent up to 50 percent. The overall concept is that water shortages of different magnitudes require different measures to overcome the deficiency.

As the City has few short term options for increasing the supply of water, the focus of this contingency plan is primarily on measures that reduce water demand. Each stage includes a set of demand reduction measures that become progressively more stringent as the shortage condition escalates (Table 7-3, *below*).

Table 7-3 Water Shortage Contingency Plan

Summary of Demand Reduction Actions and Measures		
Water Shortage Condition	**Key Water Department Communication and Operating Actions**	**Customer Demand Reduction Measures**
Stage 1: **Water Shortage Alert** **(0–5%)**	• Initiate public information and advertising campaign • Publicize suggestions and requirements to reduce water use • Adopt water shortage ordinance prohibiting nonessential uses • Step up enforcement of water waste • Coordinate conservation actions with other City Departments, green industry	• Voluntary water conservation requested of all customers • Adhere to water waste ordinance • Landscape irrigation restricted to early morning and evening • Non-essential water uses banned • Shutoff nozzles on all hoses used for any purpose • Encourage conversion to drip, low volume irrigation
Stage 2: **Water Shortage Warning** **(5–15%)**	• Intensify public information campaign • Send direct notices to all customers • Establish conservation hotline • Conduct workshops on large landscape requirements • Optimize existing water sources; intensify system leak detection and repair; suspend flushing • Increase water waste patrol • Convene and staff appeals board	• Continue all Stage 1 measures • Landscape irrigation restricted to designated watering days and times • Require large landscapes to adhere to water budgets • Prohibit exterior washing of structures • Require large users to audit premises and repair leaks • Encourage regular household meter reading and leak detection
Stage 3: **Emergency Water Shortage** **(15–25%)**	• Expand, intensify public information campaign • Provide regular media briefings; publish weekly consumption reports • Modify utility billing system and bill format to accommodate residential rationing, add penalty rates • Convert outside-City customers to monthly billing • Hire additional temporary staff in customer service, conservation, and water distribution • Give advance notice of possible moratorium on new connections if shortage continues	• Institute water rationing for residential customers • Reduce water budgets for large landscapes • Require all commercial customers to prominently display "save water" signage and develop conservation plans • Maintain restrictions on exterior washing • Continue to promote regular household meter reading and leak detection
Stage 4: **Severe Water Shortage Emergency** **(25–35%)**	• Contract with advertising agency to carry out major publicity campaign • Continue to provide regular media briefings • Open centralized drought information center • Promote gray water use to save landscaping • Scale up appeals staff and frequency of hearings • Expand water waste enforcement to 24/7 • Develop strategy to mitigate revenue losses and plan for continuing/escalating shortage	• Reduce residential water allocations • Institute water rationing for commercial customers • Minimal water budgets for large landscape customers • Prohibit turf irrigation, installation in new development • Prohibition on on-site vehicle washing • Rescind hydrant and bulk water permits
Stage 5: **Critical Water Shortage Emergency** **(35–50%)**	• Continue all previous actions • Implement crisis communications plan and campaign • Activate emergency notification lists • Coordinate with CA Department of Public Health regarding water quality, public health issues and with law enforcement and other emergency response agencies to address enforcement challenges • Continue water waster enforcement 24/7	• Further reduce residential water allocations • Reduce commercial water allocations • Prohibit outdoor irrigation • No water for recreational purposes, close pools • Continue all measures initiated in prior stages as appropriate

7.4.1 Mitigation Goals

4.1 Local Hazard Mitigation Goals — Requirement §201.6(c)(3)(i):

The hazard mitigation strategy **shall** include a description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.

Drought Goals:

1. Reduce water demand in all years through water conservation
2. Cut back water demand temporarily in drought years
3. Increase water supply

Drought Mitigation Actions:

Drought 1 — Implement the City's Water Conservation Master Plan to reduce average daily water demand and maximize the community's efficient use of water resources.

Drought 2 — Periodically update the City's Water Shortage Contingency Plan to prepare for responding to future water shortages.

Drought 3 — Implement the Water Supply Augmentation Strategy Work Plan to overcome the known worst-year supply gap of 1.2 billion gallons per year by 2025 (+/- 2 years).

7.4.2 Identification and Analysis of Mitigation Actions

4.2 Identification and Analysis of Mitigation Actions — Requirement §201.6(c)(3)(ii):

The mitigation strategy **shall** include a section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure.

Drought Mitigation Actions:

- Additional water conservation to maximize the efficient use of existing water resources. (A-11)

- Strengthen local drought resilience through improved planning and updating of the City's Water Shortage Contingency Plan, and conducting annual drought risk assessments. (A-12)
- Diligently pursue projects for regional aquifer storage to include both passive and active recharge elements. (A-12)
- Evaluate advanced treated recycled water alternatives and update seawater desalination project evaluation. (A-12)

Water Conservation

Both the state water law and the City's General Plan call for a strong emphasis on water conservation and elimination of water waste to stretch existing sources, minimize the need for new water sources, and protect the environment.

The City is implementing a Water Conservation Master Plan to maximize the community's efficient use of water. The plan includes 35 measures to be implemented over a 20 year period between 2015 through 2035. The focus of the plan is on reducing peak season water use and reducing per capita water use to the maximum extent feasible.

The primary regulatory requirement for California water utilities regarding water conservation involves preparing and submitting a complete Urban Water Management Plan (CA Water Code Sections 10601–10656). Chapter 9 of the UWMP — Demand Management Measures — outlines the City's water conservation program and addresses all mandatory elements that include: water waste prevention, metering, conservation pricing, public education and outreach, and programs to assess and manage distribution system losses. In addition, water utilities are required to calculate baseline water use and meet urban per capita water use targets in 2015 and 2020 (CA Water Code Sections 10608–10608.64). Eligibility for state grants and loans is conditioned upon an agency meeting its 2015 interim target. Chapter 5 of the plan documents that the City of Santa Cruz far surpassed its 2015 target of 111 gallons per capita day (gcpd), (actual water use was 70 gcpd) and is therefore in compliance with the requirements.

Drought Resilience

Refer to the above summary of the City's Water Shortage Contingency Plan in Section 7.4.0.

Aquifer Storage and Supply Alternatives

At the conclusion of the Water Supply Advisory Committee process a Final Report on Agreements and Recommendations was accepted by the City Council. The recommendations include strategies to overcome the 1.2 billion gallon peak supply gap during the expected worst year drought conditions. These strategies include elements of aquifer storage and development of a new water supply source.

Aquifer storage options include projects for passive recharge — in lieu through water transfers with partners who would rest production wells and active recharge — aquifer storage and recovery that injects surface water into a groundwater basin that can be drawn when needed.

Alternative supply options include projects for advanced treated recycled water and seawater desalination. These projects will consider regional collaboration and partnership in addition to increasing City supply reliability.

B ACTIONS AND PROJECTS TO REDUCE THE EFFECTS OF HAZARDS ON NEW BUILDINGS

Drought does not present a direct hazard to buildings.

C ACTIONS AND PROJECTS TO REDUCE EFFECTS OF HAZARDS ON EXISTING BUILDINGS

Drought does not present a direct hazard to buildings.

Proper maintenance and weed abatement including removal of dead landscape vegetation adjacent to buildings will reduce the threat of structure fire during dry years.

7.4.3 IMPLEMENTATION OF MITIGATION ACTIONS

4.3 Implementation of Mitigation Actions — Requirement §201.6(c)(3)(iii):

The mitigation strategy section **shall** include an action plan describing how the actions identified in section (c)(3)(ii) will be prioritized, implemented, and administered by the local jurisdiction.

Prioritization **shall** include a special emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their assorted costs.

A DISCUSSION OF PROCESS AND CRITERIA USED TO PRIORITIZE MITIGATION ACTIONS

The Water Conservation Master Plan involved analyzing water use, identifying and screening new conservation measures, and formulating programs to meet these objectives. The various measures were evaluated against the following criteria:

- Water savings potential
- Sustainable water savings
- Quantifiable water savings
- Widespread community and social acceptance
- Feasibility of implementation

The costs and benefits of different packages of programs were evaluated to aid in selecting the recommended plan.

The evaluation criteria used by the Water Supply Advisory Committee in developing its recommendations for pursuing supplemental water supply included the following:

- Technical feasibility
- Time required to demonstrate technical feasibility
- Time required to full scale production
- Adaptive flexibility
- Supply reliability
- Supply diversity
- Energy profile
- Regulatory feasibility
- Legal feasibility
- Administrative feasibility
- Potential for grants and loans
- Political feasibility
- Cost metrics

B IMPLEMENTATION AND ADMINISTRATION OF MITIGATION ACTIONS

Even though the City is already one of the top water-saving cities in the state, it is actively carrying out new programs as guided by the Water Conservation Master Plan. In 2016, the City implemented the following water conservation actions:

- Completed an exhaustive Water Loss Control Study to reduce leakage in the distribution system
- Doubled rebates for turf removal and high efficiency clothes washers
- Expanded the large landscape water budget program
- Updated the city water efficient landscape ordinance
- Implemented budget-based water rates for irrigation accounts

The City also participated in a statewide process to eliminate water waste, use water more wisely, and strengthen local drought resilience to advance progress under the California Water Action Plan and help "Make Conservation a Way of Life."

The Water Supply Augmentation Strategy is being actively implemented and steady progress continues on each element of the Work Plan. The Work Plan is designed to achieve the goal to eliminate future water shortages by the year 2025, give or take a few years. Embedded in the Work Plan are agreements that include:

- A specific goal for Yield: 1.2 BGY during modeled worst year conditions
- A timeframe for improving the reliability of supply: year 2025 (±2 years)
- Water Supply Augmentation Elements: conservation, aquifer recharge, new water supply
- An adaptive pathway to provide structure to the Work Plan progress and decision-making
- A change management strategy to guide adjustments and adaptation based on three key types of thresholds: Cost, Yield, and Timeliness

The elements of the Work Plan were selected based on two strategy options in order of preference:

Strategy 1:

Development of groundwater storage using a combination of both passive and active recharge approaches and available surface water flows during the rainy season; and

Strategy 2:

Development of advanced treated recycled water or desalinated water if and as needed to address any remaining supply-demand gap.

While the details of the elements and the proposed change management strategy can be referenced in the 2015 Urban Water Management Plan, an overview of the elements and implementation plan is described below.

Element 0:

Additional water conservation with a goal to generate an additional 200 to 250 million gallons of demand reduction by 2035 from expanded water conservation programs;

Element 1:

Passive recharge of regional aquifers by working to develop agreements for delivering surface water as an in lieu supply to the Soquel Creek Water District and/or the Scotts Valley Water Districts so they can rest their wells, help the aquifers recover, and effectively store water for use by SCWD in drought years;

Element 2:

Active recharge of regional aquifers by using existing infrastructure (wells, pipelines, and treatment capacity) and potential new infrastructure in the regionally shared Purisima aquifer in the Santa Cruz Mid-County Basin and/or in the Santa Margarita/Lompico/Butano aquifers in the Scotts Valley area to store water that can be available for use by Santa Cruz in drought years;

Element 3:

A potable water supply using advanced treated recycled water as its source, as a supplemental or replacement supply in the event the groundwater storage strategies described above prove insufficient to meet the Plan's goals of cost effectiveness, timeliness, or yield.

In the event advanced treated water does not meet the needs, desalination would then become Element 3.

The recommended Water Supply Augmentation Strategy and Work Plan include a preference for pursing a groundwater storage and retrieval strategy provided the yield goal can be achieved in a cost-effective and timely manner. Before making a choice to move away from groundwater storage, the City will diligently pursue all reasonable measures to make the groundwater strategies work.

C EMPHASIS ON THE USE OF COST–BENEFIT REVIEW

The City did not use a formal cost-benefit analysis. Costs were carefully considered when determining goals and objectives but there was not an emphasis on cost-benefit review to maximize benefits.

CLIMATE ADAPTATION CONSIDERATIONS

Santa Cruz does not import external water supplies. The amount of water available from local sources changes from year to year as a function of rainfall and runoff. The San Lorenzo River provides the largest portion of the City's water. Loch Lomond Reservoir serves as the City's primary storage reservoir.

Changing precipitation patterns that may occur as a result of climate change could significantly alter both the quantity and quality of water available to the City. More intense winter precipitation may result in lower summer base flows reducing the time window during which water can be diverted from streams. Elevated winter flows may also limit diversions due to high sediment loads. Climate change potentially impacts both pumping and precipitation patterns and the resulting ability to store water so it is available during high demand time periods.

CHAPTER 8: TSUNAMI

8.3.0 Tsunami Risk Assessment

8.3.1 Identifying Tsunami Hazards

3.1 Identifying Hazards — Requirement §201.6(c)(2)(i):

The risk assessment **shall** include a description of the type, location, and extent of all natural hazards that can affect the jurisdiction.

The plan **shall** include information on previous occurrences of hazard events and on the probability of future hazard events.

A *tsunami* is a series of waves generated by an impulsive disturbance in the ocean or in a small, connected body of water. Tsunamis are produced when movement occurs on faults in the ocean floor, usually during very large earthquakes. Sudden vertical movement of the ocean floor by fault movement displaces the overlying water column, creating a wave that travels outward from the earthquake source.

An earthquake anywhere in the Pacific can cause tsunamis around the entire Pacific basin. Since the Pacific Rim is highly seismically active, tsunamis are not uncommon. There has been minimal damage and loss of life due to tsunamis in Santa Cruz during recorded history.

Even though the potential for a significant tsunami may be low or possibly uncertain, the potential outcome of such a tsunami could be significant damage and loss of life.

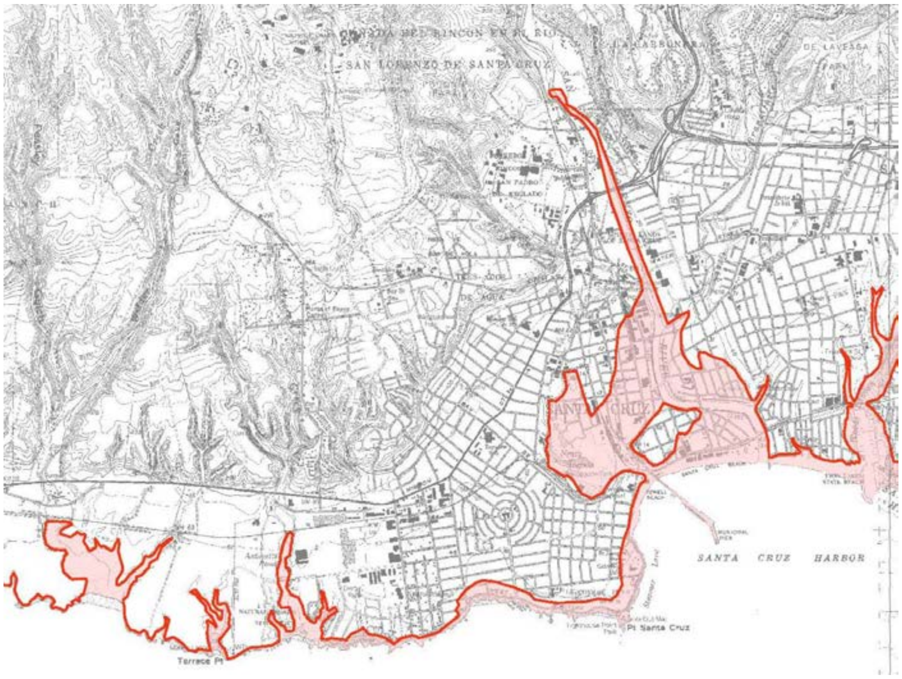
8.3.2 Profiling Tsunami Hazard Events

3.2 Profiling Hazards — Requirement §201.6(c)(2)(i):

The risk assessment **shall** include a description of the type, location, and extent of all natural hazards that can affect the jurisdiction.

The plan **shall** include information on previous occurrences of hazard events and on the probability of future hazard events.

A LOCATION



- CA Office of Emergency Services
- California Geological Survey
- Univ. of Southern California

This tsunami inundation map was prepared to assist cities and counties in identifying their tsunami hazard. It is intended for local jurisdictional, coastal evacuation planning uses only. This map and the information presented herein, is not a legal document and does not meet disclosure requirements for real estate transactions nor for any other regulatory purpose.

Tsunami Inundation Map for Emergency Planning
Detailed information available at: Tsunami Inundation Map (July 2009)

DISCLAIMER: The California Office of Emergency Services (CalOES), the University of Southern California (USC), and the California Geological Survey (CGS) make no representation or warranties regarding the accuracy of this inundation map nor the data from which the map was derived. Neither the State of California nor USC shall be liable under any circumstances for any direct, indirect, special, incidental or consequential damages with respect to any claim by any user or any third party on account of or arising from the use of this map.

Figure 19 – Tsunami Inundation Area — Worst Case Scenario (for planning purposes only)
Source: See map legend, above (2009)

The City of Santa Cruz is located on the Monterey Bay. Several active and potentially active earthquake faults are located within or near Santa Cruz. Even a moderate earthquake occurring in or near any of the nearby faults could result in local source tsunamis from submarine landsliding in Monterey Bay. Additionally, distinct source tsunamis from the Cascadia Subduction Zone to the north, or *teletsunamis* (distant-source) from elsewhere in the Pacific Ocean are also capable of causing significant destruction in Santa Cruz.

B EXTENT: MAGNITUDE OR SEVERITY

A local source tsunami generated by an earthquake on any of the faults affecting Santa Cruz could arrive just minutes after the initial shock. The lack of warning time from such a nearby event would result in higher causalities than if it were a distant tsunami where the Tsunami Warning System for the Pacific Ocean could warn threatened coastal areas in time for evacuation. Past experience has not resulted in extensive damage from tsunami, but proximity to faults does create the possibility as a result of future quakes.

C PREVIOUS OCCURRENCES

On April 1, 1946 a magnitude 7.8 earthquake in the Aleutians produced a 115-foot wave which destroyed the Scotch Cap lighthouse killing five Coast Guardsmen. It was 56 feet high in Hawaii killing 173 people. The wave was observed all along the west coast. In Santa Cruz, a man drowned and minor damage was done by 10-foot waves.[20]

It should be noted that scientific observations place the 1946 tsunami run up at 1.5 meters. It should also be noted that there are significant differences during a tsunami between maximum wave height and the maximum elevation reached by tsunami run-up, which is a function of the offshore *bathymetry* (depth measurements) and coastal topography.

In the aftermath of the 1989 Loma Prieta earthquake several docks in the Harbor became stuck to the piers and had to be lifted manually, or were broken, implying that the water level fell below the usual low tide level. Several boats were lying on the harbor floor implying a permanent change in the water level. A small tidal wave was observed rushing out of the harbor following the earthquake that continued for 15–20 minutes. The sudden water level adjustment was probably due to a vertical uplift of 4–8 inches over a ten second interval.

California is at risk from both local and distant source tsunamis. Eighty-two possible or confirmed tsunamis have been observed or recorded in California during historic times. Most of these events were small and only detected by tide gages. Eleven of these events were large enough to cause damage and four resulted in deaths. Two tsunami events caused major damage.[21]

March 2011 Tsunami

Based on the events of the March 11, 2011 Honshu, Japan earthquake and tsunami, the City, while minimally affected, had the opportunity to collaborate with the County Operational Area, and, in the aftermath, with the Santa Cruz Port District.

The City sent agency liaisons to the County Emergency Operations Center, including public safety officers and members of the city's EOC Policy group. There, they monitored State Operational Center conference calls and relayed information back to those activated in the city.

Within the City of Santa Cruz, key EOC positions were notified and activated including the EOC Manager, Director of Emergency Services, and the EOC Director. Other positions activated included Departmental Operations Center (DOC) staff from Public Works and the Parks and Recreation Departments, Police and Fire personnel. First responders closed roads, beaches and access to them, and closed off the City's Municipal Wharf.

During early recovery efforts, and due to the significant impact on the local harbor, the City of Santa Cruz and the Port District forged a mutual assistance Memorandum of Understanding.

The Santa Cruz Port District website (Santa Cruz Harbor) details the impacts and recovery from the March 11, 2011 tsunami. The Harbor is a separately governed district located within City limits. The City dispatched Public Works Associate Civil Engineers to help assess damage and plan for future rebuilding of the damaged harbor docks.

Tsunami Education and Outreach

The County, in the midst of preparing their “Tsunami Ready: Designation activities, had set up a series of community meetings on tsunami dangers and how to prepare for them. All county residents were invited to hear Steven Ward, Research Geophysicist (UCSC Institute of Geophysics and Planetary Physics) discuss “*The Local Threat of Tsunamis*” and to view the latest inundation area maps for their neighborhoods. The City’s community room (located in the former EOC) was packed with a standing room only crowd of about 250 residents. The public meeting, while having long been scheduled, followed just a mere 10 days after the actual event.

The City of Santa Cruz EOC Manager participated in the initial community meeting and then another one a week later that was arranged for mono-lingual Spanish speaking residents in the Lower Ocean Street and Beach Flats neighborhoods.

CalOES and the California Geological Survey have partnered to develop the *Tsunami Response Playbook* (2014) for local agencies.

> To provide more detailed information for secondary evacuation zones, tsunami evacuation “playbooks” have been developed to plan for tsunami scenarios of various sizes and source locations. NOAA-issued Tsunami Alert Bulletins received in advance of a distant event will contain a forecasted tsunami amplitude, or wave height, and arrival time for a number of locations along the coastline. Elevation “playbook” evacuation lines can be useful for partial tsunami evacuations when information about forecasted tsunami amplitudes and arrival times is available to coastal communities and there is sufficient time to implement a partial evacuation. Provision for multiple elevation evacuation lines and response plans for those lines enables planning for different evacuation scenarios based on the forecast tsunami amplitude, potentially alleviating the need for an “all or nothing” decision with regard to evacuation.
>
> Scenario tsunami playbooks and guidance have been developed for maximum local and regional tsunamis, and for tsunamis generated by the Cascadia Subduction Zone that impact central and southern California. Scenario playbook information about the expected tsunami amplitude and travel time is available from the numerical modeling results for these sources. These are important scenarios for emergency managers to prepare for as there could only be ten to fifteen minutes to evacuate before a local tsunami arrives, or just a few hours to conduct response or evacuation activities before a regional tsunami arrives. To assist in the decision making process of what level of evacuation should occur, an analytical tool called the “FASTER” approach has been developed that takes the forecast amplitude of the tsunamis and integrates other factors influencing tsunami inundation, including storm, tides, modeling errors, and location specific tsunami run-up potential. Both the evacuation playbooks and FASTER approach will help communities better evaluate the amount of expected flooding, and implement evacuations and response activities for minor to moderate (less than maximum) tsunami events (i.e. events where the worst-case scenario evacuation may be excessive).

Source: California Geological Survey

Table 8-1 Locally Generated Tsunami Source

Source Zone	Major Offshore Faults	Major Submarine Canyons	Earthquake Magnitude (Year)	Historical Tsunami Run-up (Year)
San Francisco to Monterey	San Gregorio Fault(s)	Pioneer, Ascension, Monterey	M = 7.1 (1989)	0.3 meters (1989)

D PROBABILITY OF FUTURE EVENTS

Tsunami Hazard

Prior to the impacts from the March 11, 2011 Tohoku, Honshu Island tsunami, historically, this portion of the California coast has not been subject to significant tsunami hazards although more than twenty tsunamis of different heights have been observed or recorded in the past two centuries. Given the intense coastal land use and recreational activities along the coast, even a small hazard may pose high risk.[22] Appendix J lists tsunami heights recorded around Monterey Bay as a result of the three major earthquakes around the Pacific Ocean in the last 50 years. Maximum tsunami wave heights reached nine feet (2.7 meters) at Monterey harbor due to the 1964 Alaskan earthquake.

The US Army Corps of Engineers has looked at potential earthquake sources around the Pacific and modeled expected tsunami impacts on the coast of the Monterey Bay (US Army Corps of Engineers, 1975). Their study estimated that a tsunami wave with a probability of occurrence of one every 100 years would be about 5.9 feet high. A tsunami with a probability of occurrence of one every 500 years is expected to be 11.5 feet high.

More recently, studies have been undertaken by Richard K. Eisner, Jose C. Borrero and Costas E. Synolakis through the Governor's Office of Emergency Services and the Department of Civil Engineering at the University of Southern California, Los Angeles. In *Inundation Maps for the State of California* the authors clarify that the results are based on worst case scenario events and the maps they have produced are meant to be used for emergency preparedness and evacuation pre-planning.

Pre-1994 inundation computations underestimated inundation heights. Newer inundation models have now proven capable of modeling extreme events accurately. These new inundation models (known as MOST, for "Method of Splitting Tsunami"), permit quantitative evaluation of the inundation from *near-field* tsunamis (thirty minutes or less travel time), provided accurate regional tectonic models exist and accurate high resolution bathymetry. Even using state of the art inundation prediction tools, California presents unique challenges in assessing tsunami hazards.

Unique challenges in assessing tsunami hazards:

- There is an extremely short historic record of tsunamis in the state. In California there are no known records before the 19th century.
- Most of the geologic work in the state has concentrated on identifying the risks associated with onshore faults and there is scant information available on offshore faults or landslide and slump scars that are suggestive of past submarine mass failures.
- Earlier estimates of tsunami hazards relied almost entirely on far field sources and used pre-1980's technology, creating the impression among planners and the public that the tsunami hazard was small.
- Near-shore seismic events may trigger tsunamis arriving within less than 20 minutes, allowing little time for evacuation.[23]

The perception in California is that tsunamis are extreme events, and that there is very little we can do to mitigate the hazards. Costas Synolakis, director of the Tsunami Research Center at the University of Southern California states, "In reality, until recently we have not been able to model tsunamis adequately. It was a hazard that was ignored."

Synolakis and Borrero first proposed mapping California's tsunami zones in 1995. It's a complex undertaking that goes far beyond drawing a line on a map. In any given place, the height of the wave depends on the contours of the ocean bottom.

Ultimately, Synolakis said, California needs hazard maps that reflect the probability of flooding from tsunamis set off by specific earthquakes, not just general worst case scenarios.[24]

8.3.3 ASSESSING TSUNAMI VULNERABILITY: OVERVIEW

> **3.3 Assessing Vulnerability: Overview — Requirement §201.6(c)(2)(ii):**
>
> The risk assessment **shall** include a description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section.
>
> This description **shall** include an overall summary of each hazard and its impact on the community.

A OVERALL SUMMARY OF VULNERABILITY TO TSUNAMI

There are two primary types of tsunami vulnerability in Santa Cruz. The first is a distant source tsunami from elsewhere in the Pacific Ocean. This type of tsunami is capable of causing significant destruction in Santa Cruz. However, this type of tsunami would usually allow time for the Tsunami Warning System for the Pacific Ocean to warn at risk and threatened coastal areas in time for evacuation.

The more vulnerable risk to the City of Santa Cruz is a tsunami generated as the result of an earthquake along one of the many earthquake faults in the region. Even a moderate earthquake occurring in or near the areas mentioned above could result in local source tsunamis from submarine landsliding in Monterey Bay.

A local source tsunami generated by an earthquake on any of the faults affecting Santa Cruz would arrive just minutes after the initial shock. The lack of warning time from such a nearby event would result in higher causalities than if it were a distant tsunami.

8.3.4 Assessing Vulnerability: Identifying Structures

> **3.4 Assessing Vulnerability: Identifying Structures — Requirement §201.6(c)(2)(ii)(A):**
>
> The plan **should** describe vulnerability in terms of the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard area.

A TYPES AND NUMBERS OF EXISTING BUILDINGS, FACILITIES AND INFRASTRUCTURE

Much of the downtown and the beach areas including the core commercial centers are in the mapped tsunami inundation zone. Most of the city and county government buildings and the Lifeguard and Marine Safety Headquarters on the Municipal Wharf are located in the inundation threat zone. The tsunami inundation threat zone includes the following:

- 3,191 structures
- Central Fire Station
- Police Station
- City Hall campus
- Lifeguard and Marine Safety Headquarters
- County Government Center
- 29 schools and day care centers

8.3.5 ASSESSING VULNERABILITY: ESTIMATING POTENTIAL LOSSES

3.5 Assessing Vulnerability: Estimating Potential Losses — Requirement §201.6(c)(2)(ii)(B):

The plan **should** describe vulnerability in terms of an estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(i)(A) of this section and a description of the methodology used to prepare the estimate.

A POTENTIAL DOLLAR LOSSES TO VULNERABLE STRUCTURES

Table 8-2 Tsunami potential loss inventory

Inventory Assets								
TSUNAMI								
	# of Parcels		**# of Structures**		**Critical Structures**		**Loss in Value$***	
Type	**Total**	**Hazard**	**Total**	**Hazard**	**Total**	**Hazard**	**Total**	**Hazard**
Residential	14,916	1,189	17,363	1,589			$9,263,773,000	$986,835,911
Commercial	1,524	405	1,310	220			$2,309,879,000	$536,777,720
Industrial	307	2	299	25			$495,671,000	$25,859,985
Agricultural	5	2	51	6			$29,942,000	$3,718,454
Religion	56	8	99	11			$168,168,0000	$22,784,103
Government	217	116	30	0			$85,229,000	$160,640
Education	228	1	57	12			$128,938,000	$28,736,000
Total	**17,253**	**1,723**	**19,217**	**1,856**	**35**	**4**	**$12,541,502,000**	**$1,608,785,273**
	Community	**Hazard**						
# of People	**62,752**	**14,165**						
Date: Census American Community Survey 2015								
Total = total number of structures, residents, values within the entire community								
Hazard= number of structures, residents, values that are located within the defined hazard area								
*Government Parcels, Public Schools and most Utilities are not assessed.								
Parcel Data is from January 2017. Building Count/Total Replacement Value data is from 2014.								

B METHODOLOGY USED TO PREPARE ESTIMATE

Parcel Valuation:
Total Building Replacement Value (Building and Contents) and Building Count (Structure Count) from HAZUS-MH 3.2 Release 14.2.0. This data is from 2014.

Population:
Census population blocks were reduced to center points. If a hazard intersected a center point, that population was counted.

Flood Analysis:
Tsunamis create many risks similar to flood and the tsunami and flood risk areas are almost identical. Since FEMA flood data is mapped on the federal level, the data is extremely coarse in horizontal accuracy. The data was not meant to be measured against parcel level information and therefore is a rough estimate of damage and loss in a worst case scenario.

8.3.6 Assessing Vulnerability: Analyzing Development Trends

3.6 Assessing Vulnerability: Analyzing Development Trends — Requirement §201.6(c)(2)(ii)(C):

The plan **should** describe vulnerability in terms of providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.

A DESCRIPTION OF LAND-USES AND DEVELOPMENT TRENDS

As was described previously, the City of Santa Cruz is a compact urban community that is surrounded by natural barriers to outward expansion including the Santa Cruz Mountains, the Pacific Ocean and a designated greenbelt. In Santa Cruz, most development is now infill or reuse development.[25] The beach and downtown commercial areas are in the 100-year floodplain which is similar to the tsunami inundation area. Increasing residential density and mixed use development continue in the downtown core.

The City is required by Associated Monterey Bay Area Governments (AMBAG) to zone to allow for its share of housing. Some of the potential housing properties identified with the highest density zoning are located in the tsunami inundation area.

8.4.0 Mitigation Strategy

4.0 Mitigation Strategy — Requirements §201.6(c)(3):

The plan **shall** include a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs and resources, and its ability to expand on and improve these existing tools.

Mitigation strategy includes continuation of an up to date Emergency Operations Plan, an effective public information program and continuing collaborative efforts with the County, other cities, agencies and community organizations to facilitate joint efforts in providing up-to-date tsunami mapping, preparation, information, warning dissemination and education.

Mapping of tsunami inundation areas in Santa Cruz including the map used in this plan have been improved. The map (Figure 19, *above*) should be viewed as an estimate of a worst case scenario for planning purposes only. More accurate mapping of potential tsunami outcomes based on simulations of specific geologic events has been identified as an important component in preparing updates to this Local Hazard Mitigation Plan.

8.4.1 Mitigation Goals

> **4.1 Local Hazard Mitigation Goals – Requirements §201.6(c)(3)(i):**
>
> The hazard mitigation strategy **shall** include a description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.

Tsunami Goals:

Tsunami 1 — Avoid or reduce the potential for life loss, injury, property and economic damage to Santa Cruz from tsunami events.

Tsunami 2 — Continue to enhance emergency management systems including a defined public information process that includes an early warning system for evacuation prior to a tsunami event.

8.4.2 Identification and Analysis of Mitigation Actions

> **4.2 Identification and Analysis of Mitigation Actions — Requirement §201.6(c)(3)(ii):**
>
> The mitigation strategy **shall** include a section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure.

"Tsunami Ready" Designation

The City of Santa Cruz has embarked on a plan to obtain Tsunami Ready status. GIS staff, engineers and operations personnel have mapped locations for tsunami signage. This effort has been held back somewhat due to staffing and budget constraints. However, the County has completed their effort, and the city is "surrounded" by tsunami-related signage. In the next LHMP update cycle the city hopes to complete Tsunami Ready efforts by December 2018.

Tsunami Mitigation Actions:

- Coordination with other agencies including Santa Cruz County (A-2)
- Management of the early warning system. (B-4)
- Tsunami and Floodplain development regulations (B-5)
- Encouraging participation in Federal Flood Insurance Program (B-6)

CHAPTER 9: COASTAL EROSION

9.3.0 Coastal Erosion Risk Assessment

9.3.1 Identifying Coastal Erosion Hazards

3.1 Identifying Hazards — Requirement §201.6(c)(2)(i):

The risk assessment **shall** include a description of the type, location, and extent of all natural hazards that can affect the jurisdiction.

The plan **shall** include information on previous occurrences of hazard events and on the probability of future hazard events.

Coastal erosion is the wearing away of coastal land. It is commonly used to describe the horizontal retreat of the shoreline along the ocean. Erosion is considered a function of larger processes of shoreline change, which include *erosion* and *accretion*. Erosion results when more sediment is lost along a particular shoreline than is re-deposited by the water body. Accretion results when more sediment is deposited along a particular shoreline than is lost. When these two processes are balanced, the shoreline is said to be stable.

Erosion is measured as a rate, with respect to either a linear retreat (feet of shoreline recession per year) or volumetric loss (cubic yards of eroded sediment per linear foot of shoreline frontage per year.)[26]

Erosion rates are not uniform, and vary over time at any single location. Annual variations are the result of seasonal changes in wave action and water levels. Erosion is caused by coastal storms and flood events, changes in the geometry of tidal inlets and bays and man-made structures and human activities such as shore protection structures and dredging.

Coastal erosion includes both cliff or bluff erosion and beach erosion, and is a result of both winter wave attack as well as a slowly rising sea level. Local residents will notice that beaches change seasonally in response to changes in wave conditions. Winter storm waves are larger, steeper and contain more energy, and typically move significant amounts of sand from the beaches to offshore bars, creating steep, narrow beaches. In the summer, lower, less energetic waves return the sand, widening beaches and creating gentle slopes. During the winter months when beaches are narrow, or absent altogether, the storm waves attack the cliffs and bluffs more frequently. There are so many factors involved in coastal erosion, including human activity, sea-level rise, seasonal fluctuations and climate change, that sand movement will not be consistent year after year in the same location.

Wind, waves, and the long-shore currents are the driving forces behind coastal erosion. The removal and deposition of sand creates long-term changes to beach shape and structure. Sand may be transported to land-side dunes, deep ocean trenches, other beaches and deep ocean bottoms.

CLIMATE ADAPTATION CONSIDERATIONS

As noted in the City of Santa Cruz Climate Adaption Plan (*see* Appendix P), the impacts of coastal erosion have, in the past, been significant. Any increase in coastal storm frequency or severity will increase coastal cliff retreat rates. This will in turn endanger coastal properties and infrastructure. The 2011 Climate Adaptation Vulnerability Study, in the previous LHMP Update, outlined the history of coastal erosion and noted the potential impacts that climate change may have on our local beach frontage and cliffs. These impacts range from issues at the Santa Cruz Harbor, beach and cliff frontage at the mouth of the San Lorenzo River, coastal bicycle paths and areas around the historic Lighthouse.

In 2017, a revised Vulnerability Assessment was conducted, identifying the impacts from erosion influenced by sea level rise. Erosion hazard zones were projected and mapped for years 2030, 2060 and 2100, quantified in terms of number of damaged or lost facilities and assets and their value, and potential effects on socially vulnerable populations.

9.3.2 Profiling Coastal Erosion Hazard Events

3.2 Profiling Hazards — Requirement §201.6(c)(2)(i):

The risk assessment **shall** include a description of the type, location, and extent of all natural hazards that can affect the jurisdiction.

The plan **shall** include information on previous occurrences of hazard events and on the probability of future hazard events.

A LOCATION

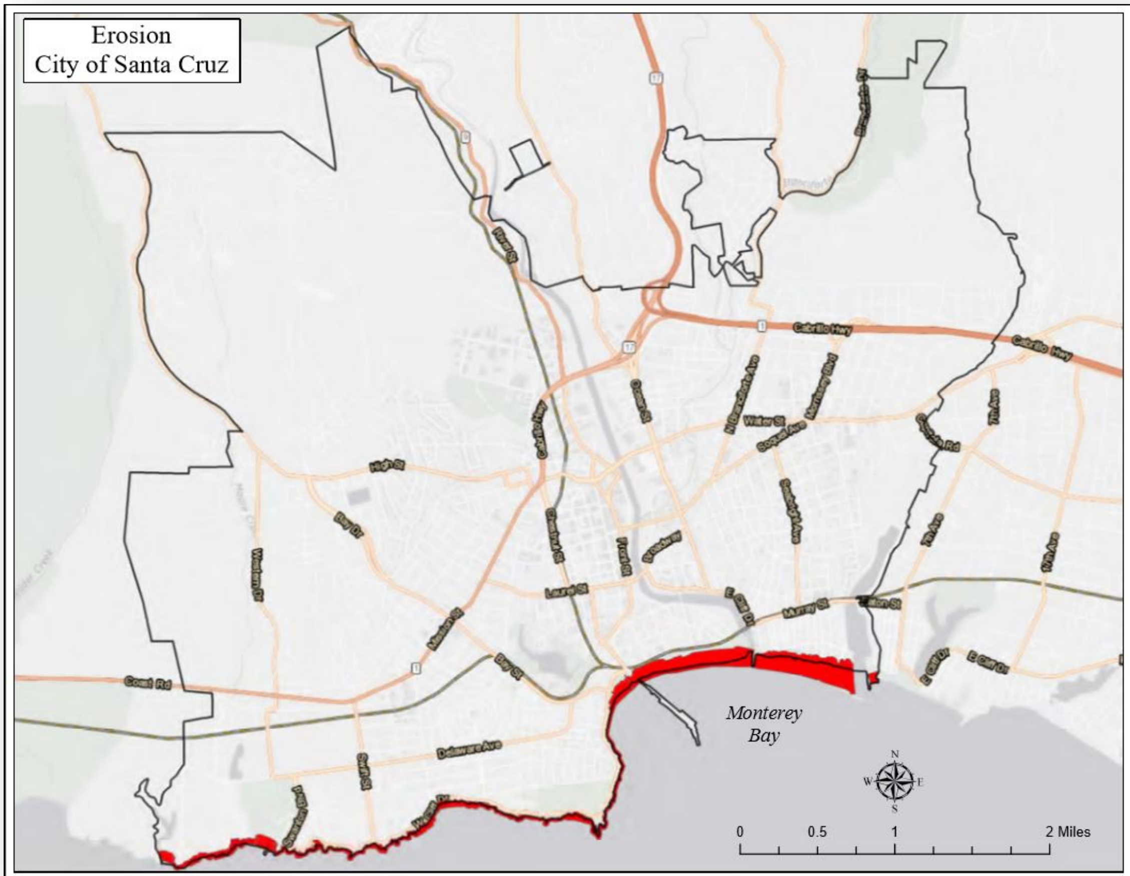


Figure 20 – Areas Susceptible to Coastal Erosion *Source*: City of Santa Cruz GIS (2017)

The City of Santa Cruz is bounded on one side by the Pacific Ocean. The entire coastal edge of the City is affected by coastal erosion. West Cliff Drive from Cowell Beach to Natural Bridges State Park is at the highest risk of, and continues to be shaped and impacted by, coastal erosion.

B EXTENT: MAGNITUDE OR SEVERITY

Most of the significant cliff, bluff or dune erosion occurs during the winter months at times of very high tides and large storm waves. All of the cliffs along the ocean in the City of Santa Cruz and some along the San Lorenzo River experience some degree of coastal erosion. Some portions of the roadway and bicycle path along West Cliff Drive are at risk of being lost. The Lighthouse Museum and its supporting structures on West Cliff Drive are also at risk due to coastal erosion.

C PREVIOUS OCCURRENCES

Approximately 85 percent of the California coast is actively eroding due to complex oceanographic and geologic conditions and human activities that affect the delivery and movement of sand along the coast.[27] Within the City of Santa Cruz, the most threatened area is West Cliff Drive where beaches are narrow or non-existent so that waves attack the bluffs and cliff directly during winter high tides.[28]

During the severe El Niño winters of 1983 and 1997–98, sea levels were further elevated and storm damage along the West Cliff Drive area was extensive. Wave attack combined with a global rise in sea level over the past 18,000 years has led to the continued migration of the shoreline. At the end of the last Ice Age about 18,000 years ago, the coastline at Santa Cruz was about 10 miles offshore. As the ice sheets and glaciers melted, sea level gradually rose and continues to rise today.

Rising sea levels and winter wave attack have led to the retreat of the Santa Cruz coastline; this process will continue into the future. Over the past several decades it has been discovered that climate and storm frequency are related to larger scale climatic oscillations that affect the entire Pacific Ocean. During the time period from about 1945 to 1978, the California coast was characterized by a fairly calm climate, few large storms, less rainfall and less coastal erosion and storm damage. Beginning in 1978 and continuing until 1998, California experienced a period of more frequent and severe El Niño events with associated elevated sea levels, large waves, heavier rainfall and more extensive coastal storm damage and cliff and beach erosion.

D PROBABILITY OF FUTURE EVENTS

While the sea level rose a little less than a foot over the past century, most scientists are concerned that due to the increase in greenhouse gases from human activity, warming will accelerate. As a result, glaciers will continue to retreat and the rate of sea level rise will increase, with the best estimate being about 3 feet higher by 2100*. Given these estimates, the probability of future coastal erosion is very high. We define “very high” as each five (5) years = 20% chance in any given year.

**see*, City of Santa Cruz Climate Adaptation Plan, Chapter 3 (LHMP Appendix P)
Source, California Ocean Protection Council

While we do not have statistical information that would put a percentage value to the qualitative description of probability being “very high” the following is an explanation of how the sea level rise scenarios that were selected for analysis pursuant to the Coastal Commission recommendations are described.

> The sea level rise projections are by Environmental Science Associates and are based on the emissions scenarios contained in the 2012 National Research Council Report, *Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future*. This report handles “certainty.” No formal probability analysis of the individual contributors of uncertainty was performed, so the

projections are not necessarily the likeliest outcomes, and the ranges are not the highest or lowest possibilities.

9.3.3 Assessing Coastal Erosion Vulnerability: Overview

> **3.3 Assessing Vulnerability: Overview — Requirement §201.6(c)(2)(ii):**
>
> The risk assessment **shall** include a description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section.
>
> This description **shall** include an overall summary of each hazard and its impact on the community.

A OVERALL SUMMARY OF VULNERABILITY TO COASTAL EROSION

Much of the West Cliff Drive coastline has been progressively armored with rip rap over the past 40 years. In 1990 the California Department of Boating and Waterways granted the City approximately four million dollars for coastal armoring. During the 1980s and 1990s the Highway Administration gave the City approximately five million dollars to repair coastal erosion as a part of declared disasters within the City.

The impact of wave attack has been slowed in some areas, although large winter waves can still overtop cliffs and threaten pathways and parking areas. The Woodrow Drive area (along West Cliff) is a good example of wave overtopping because it is at a lower elevation. Lighthouse Point is another site where some protection exists but continued wave attack has created several large caves that extend under the pathway and are getting closer to the lighthouse. Ongoing coastal erosion is a significant problem along West Cliff Drive and this will continue as sea levels continue to rise.

9.3.4 Assessing Vulnerability: Identifying Structures

> **3.4 Assessing Vulnerability: Identifying Structures — Requirement §201.6(c)(2)(ii)(A):**
>
> The plan **should** describe vulnerability in terms of the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard area.

A TYPES AND NUMBERS OF EXISTING BUILDINGS, FACILITIES AND INFRASTRUCTURE

Although there are only a few houses, two hotels and one City museum along the ocean cliff frontage, the City is attempting to preserve a significant amount of infrastructure including roadways, bike paths, parks and storm drains which are continually threatened by coastal erosion. Additionally, the Santa Cruz Harbor, beach frontage, and cliff frontage near the mouth of the San Lorenzo River are also threatened by varying degrees of erosion.

Coastal erosion impacts to the city potentially include:

- Structural shifting or damage
- Damage to roads
- Impacts to tourism and tourist serving facilities
- Damage to residential property
- Shifts in natural habitat
- Loss of beach area
- Damage to utility infrastructure

Information on beach erosion is unknown at this time, however considering that Santa Cruz is a beach/tourist destination, any loss of beach availability due to erosion would have economic impacts (also undetermined at this time).

9.3.5 ASSESSING VULNERABILITY: ESTIMATING POTENTIAL LOSSES

3.5 Assessing Vulnerability: Estimating Potential Losses — Requirement §201.6(c)(2)(ii)(B):

The plan **should** describe vulnerability in terms of an estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(i)(A) of this section and a description of the methodology used to prepare the estimate.

A POTENTIAL DOLLAR LOSSES TO VULNERABLE STRUCTURES

Table 9-1 Coastal Erosion Potential Loss Inventory

COASTAL EROSION								
	# of Parcels		# of Structures		Critical Structures		Loss in Value$*	
Type	**Total**	**Hazard**	**Total**	**Hazard**	**Total**	**Hazard**	**Total**	**Hazard**
Residential	14,916		17,363	50			$9,263,773,000	$32,928,480
Commercial	1,524		1,310	7			$2,309,879,000	$11,735,655
Industrial	307		299	1			$495,671,000	$1,112,865
Agricultural	5		51	1			$29,942,000	$227,780
Religion	56		99	0			$168,168,000	$0
Government	217		30	0			$85,229,000	$0
Education	228		65	0			$188,840,000	$0
Total	**17,253**	**72**	**19,217**	**59**	**35**	**0**	**$12,541,502,000**	**$46,004,779**
# of People	**59,946**	**2,563**						
Date: Census American Community Survey 2015								
Total = total number of structures, residents, values within the entire community								
Hazard= number of structures, residents, values that are located within the defined hazard area								
*Critical Structures include the Municipal Wharf and Harbor								
Parcel Data is from January 2017. Building Count/Total Replacement Value data is from 2014.								

B METHODOLOGY USED TO PREPARE ESTIMATE

Parcel Valuation:
Total Building Replacement Value (Building and Contents) and Building Count (Structure Count) from HAZUS-MH 3.2 Release 14.2.0. This data is from 2014.

Not included in the valuation:
Potential dollar losses including replacement of roads, paths and lighthouse including property acquisition.

9.3.6 Assessing Vulnerability: Analyzing Development Trends

3.6 Assessing Vulnerability: Analyzing Development Trends — Requirement §201.6(c)(2)(ii)(C):

The plan **should** describe vulnerability in terms of providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.

A DESCRIPTION OF LAND-USES AND DEVELOPMENT TRENDS

Every coastal community in California is dealing with the issues of sea level rise and shoreline retreat. The armoring of the shoreline is becoming an increasingly controversial and contentious issue. Coastal erosion poses many problems to coastal communities in that valuable property is frequently lost to this dynamic beach-ocean system. Additionally, human activity may promulgate the process of coastal erosion through poor land use methods. Thus, issues of beach restoration and erosion control are at the forefront in coastal communities.

Santa Cruz' shoreline is now part of the Monterey Bay Marine Sanctuary which will also influence development trends along the Santa Cruz coast. Protecting the natural resources of the area as well as preserving the infrastructure that is already in place, such as the lighthouse and bike path, are the primary land use objectives.

9.4.0 Mitigation Strategy

4.0 Mitigation Strategy — Requirement §201.6(c)(3):

The plan **shall** include a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment based on existing authorities, policies, programs and resources, and its ability to expand on and improve these existing tools.

9.4.1 Mitigation Goals

4.1 Local Hazard Mitigation Goals — **Requirement §201.6(c)(3)(i):** The hazard mitigation strategy **shall** include a description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.

Coastal Erosion Goals:

Coastal Erosion 1 — Avoid or reduce the potential for life loss, injury, property and economic damage to Santa Cruz from coastal erosion.

Coastal Erosion 2 — Protect and preserve natural resources.

Coastal Erosion 3 — Protect and preserve current infrastructure.

9.4.2 Identification and Analysis of Mitigation Actions

4.2 Identification and Analysis of Mitigation Actions — **Requirement §201.6(c)(3)(ii):** The mitigation strategy **shall** include a section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure.

Coastal Erosion Mitigation Actions

- Protect and preserve coastline through permit review. (B-2)
- Protect and preserve coastline and infrastructure through restoration efforts. (B-3)

Minimizing Hazards from Coastal Erosion

Much of the West Cliff coastline has boulder riprap and some concrete retaining structures to protect the cliff. Other options include seawalls and jetties to minimize the energetic wave impacts that drive cliff erosion. Because these structures have finite life spans and may have adverse effects on other parts of the coast, engineering solutions can be very expensive in both the short- and long-term. In other cases, the solution is to leave the coastline relatively undeveloped and to allow erosion to occur naturally. This option allows for greater public access to the coastline. It also preserves the normal input of sand into the drift system, perhaps lessening erosion at neighboring beaches.

The three primary management strategies that may be used to plan for, and respond to, coastal erosion are hazard reduction, relocation, and coastal protection. The maximum potential efficacy and acceptability of these strategies can best be determined with multi-disciplinary project planning, design, monitoring and evaluation.

Hazard Reduction — A Commonsense Approach

The most logical method for preventing potential damage to new development in the coastal zone is to not build where coastal erosion will impact such development. This concept, known as *hazard reduction*, could circumvent many subsequent permitting and legal challenges. Hazard reduction has proven effective when used in a number of ways including designing public infrastructure to discourage development in high geologic hazard areas along the coast. Santa Cruz already has a developed coastline including significant City owned infrastructure along the cliffs including roadways, bike paths, parks and park facilities.

Relocation — Moving Development Out of Harm's Way

Another approach to consider under certain circumstances is the concept of *managed retreat*, that is, the gradual removal or abandonment of development from areas of high geologic hazard. In the context of coastal management, the concept of managed retreat acknowledges the natural erosive processes at work along the coast.

In some instances development is sited in unstable, erosion-prone areas that may be damaged or destroyed by natural processes acting on the coast. Relocating existing public or private development away from the erosion-prone area may be the most effective long-term option when responding to the eventual or imminent threat of damage. While relocating coastal development away from hazardous areas would be the most direct way to eliminate the risk of damage and the need for coastal protection, this response may not be technically feasible.

Coastal Protection

In situations where hazard reduction and relocation are not viable options, coastal protection strategies can be used to reduce the potential for beach loss and coastal erosion. There are two general types of coastal protection, *hard* and *soft*. A "hard" protection device utilizes concrete or rock in a variety of configurations to absorb or dissipate storm wave energy, generally in the form of seawalls, revetments or bulkheads. "Soft" protection primarily involves dune or beach restoration or enhancement to reduce the chances of storm waves reaching the backshore. A hard protection device differs from most soft erosion response alternatives in that it does not add sand to the system of sediment.

CLIMATE ADAPTATION CONSIDERATIONS

As noted earlier in this chapter, Santa Cruz has experienced significant erosion in the past. An increase in coastal storm frequency and/or magnitude would increase cliff retreat rates and resulting damage to oceanfront property and City infrastructure.

The City has a developed coastline including significant City owned infrastructure along the cliffs, specifically, roadways, bicycle paths, parks and park facilities. In addition to City infrastructure there are a few houses, two hotels and one City museum along the ocean cliff frontage. The Santa Cruz Harbor, beach frontage, and cliff frontage near the mouth of the San Lorenzo River are also threatened by varying degrees of erosion which may occur more rapidly in the future as a result of climate change impacts.

Protecting the natural resources of the area as well as preserving the infrastructure that is already in place, such as the lighthouse and bicycle path, are primary land use objectives. There has been discussion of relocating the lighthouse if the coastal caves show evidence of collapsing. Additionally, the bicycle path may be relocated in the future for the same reason.

CHAPTER 10: DAM FAILURE — LESSER RISK

10.3.0 Dam Failure Risk Assessment

10.3.1 Identifying Dam Failure Hazards

3.1 Identifying Hazards — Requirement §201.6(c)(2)(i):

The risk assessment **shall** include a description of the type, location, and extent of all natural hazards that can affect the jurisdiction.

The plan **shall** include information on previous occurrences of hazard events and on the probability of future hazard events.

Dam failure can occur as a result of earthquakes, *seiches* (surface water movement), structural instability, or intense rain in excess of design capacity. Timber, rock, concrete, earth, steel or a combination of these materials may be used to build the dam. Dams must have spillway systems to safely convey normal stream and flood flows over, around, or through the dam. Spillways are commonly constructed of non-erosive materials such as concrete. Dams also have a drain or other water withdrawal facility to control the reservoir level and to lower or drain the reservoir for normal maintenance and emergency purposes.

10.3.2 Profiling Dam Failure Hazard Events

3.2 Profiling Hazards — Requirement §201.6(c)(2)(i):

The risk assessment **shall** include a description of the type, location, and extent of all natural hazards that can affect the jurisdiction.

The plan **shall** include information on previous occurrences of hazard events and on the probability of future hazard events.

A LOCATION

The City of Santa Cruz owns and operates one dam. Newell Creek Dam is located near the town of Ben Lomond in the Santa Cruz Mountains and impounds Newell Creek to form Loch Lomond Reservoir. The reservoir was constructed in the early 1960s and has a maximum capacity of approximately 2.9 billion gallons.

Loch Lomond Reservoir is the City's primary raw water storage facility. Dams are under the jurisdiction of the California Department of Water Resources, Division of Safety of Dams

(DSOD). The Water Department maintains maps and information on water system facilities including Loch Lomond. For security reasons, information regarding these documents is intentionally general in nature, omitting confidential details and effected assets.

B EXTENT: MAGNITUDE OR SEVERITY

A major dam failure at Newell Creek Dam could result in extensive property damage and loss of life.

C PREVIOUS OCCURRENCES

There have been no reported potential emergencies or dam failures at Newell Creek Dam.

D PROBABILITY OF FUTURE EVENTS

Accumulated data, ongoing analyses, and monitoring of critical dam infrastructure (e.g., spillway) give no indication that the dam would fail or otherwise sustain damage under normal circumstances including historic flood events, potential earthquakes, and other hazards. This does not include man-made disasters or a catastrophic event.

10.3.3 Assessing Dam Failure Vulnerability: Overview

3.3 Assessing Vulnerability: Overview — Requirements §201.6(c)(2)(ii):

The risk assessment **shall** include a description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section.

This description **shall** include an overall summary of each hazard and its impact on the community.

A OVERALL SUMMARY OF VULNERABILITY TO DAM FAILURE

The losses to life and property associated with complete dam failure would be high. Given the monitoring protocol, level of security, and infrastructure design capacities; the probability of dam failure is very low.

10.3.4 Assessing Vulnerability: Identifying Structures

3.4 Assessing Vulnerability: Identifying Structures — Requirement §201.6(c)(2)(ii)(A):

The plan **should** describe vulnerability in terms of the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard area.

In 2007, the California Department of Water Resources, Division of Safety of Dams conducted a seismic stability analysis of Newell Creek Dam. Analysis parameters included an M7.0 event on the Zayante Fault and an M8.0 event on the San Andreas Fault. In 2009, the City received confirmation that the analysis concluded that "the dam is safe for continued use" under these parameters. In 2016, DSOD confirmed this analysis was still valid.

A TYPES AND NUMBERS OF EXISTING BUILDINGS, FACILITIES AND INFRASTRUCTURE

A dam failure would result in significant downstream flooding to buildings, infrastructure and critical facilities located along Newell Creek and the San Lorenzo River. The downstream hazard area includes Ben Lomond, Glen Arbor, Felton, Beulah Park, Paradise Park, and downtown Santa Cruz. Critical facilities located in the flood path include the City Corporation Yard, Coast Pump station, City Hall, Fire Station #1, Fire Administration Building, Civic Auditorium, Post Office, Police Department and Louden Nelson Community Center.

The Water Department is currently in the process of updating its dam failure inundation maps using modern methodologies and data to:

1. Reflect new development in the downstream flood zone
2. Assist with determination of evacuation zones, and
3. Identify all buildings, facilities and infrastructure located within the inundation limits

10.3.5 Assessing Vulnerability: Estimating Potential Losses

> **3.5 Assessing Vulnerability: Estimating Potential Losses — Requirement §201.6(c)(2)(ii)(B):**
>
> The plan **should** describe vulnerability in terms of an estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(i)(A) of this section and a description of the methodology used to prepare the estimate.

A DOLLAR LOSSES TO VULNERABLE STRUCTURES

This information is not available at this time.

B METHODOLOGY USED TO PREPARE ESTIMATE

This information is not available at this time.

10.3.6 Assessing Vulnerability: Analyzing Development Trends

> **3.6 Assessing Vulnerability: Analyzing Development Trends — Requirement §201.6(c)(2)(ii)(C):**
>
> The plan **should** describe vulnerability in terms of providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.

A DESCRIPTION OF LAND-USES AND DEVELOPMENT TRENDS

As was stated earlier, the City of Santa Cruz is a compact urban community that is surrounded by natural barriers to outward expansion including the Santa Cruz Mountains, the Pacific Ocean and a designated greenbelt.

Ongoing population growth in the area has been mirrored by an increase in urbanization for the Monterey Bay area. Development patterns in the coastal zone since the 1970s confirm these overall urbanizing trends. New development has occurred within or adjacent to the urban services line (i.e., the boundary point for such infrastructure as gas, water, and sewage hook-ups). In Santa Cruz, most development is now infill or reuse development.[29]

Increasing population densities expands the potential population and property at risk from a dam failure.

10.4.0 Mitigation Strategy

> **4.0 Mitigation Strategy — Requirement §201.6(c)(3):**
>
> The plan **shall** include a mitigation strategy that provides the jurisdiction’s blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs and resources, and its ability to expand on and improve these existing tools.

The primary mitigation strategy is the continuation of monitoring protocols for structural integrity. These include the monitoring of the Newell Creek Dam as follows:

- Water pressures within the dam and seepage are monitored monthly and after established rainfall and earthquake triggers.
- Critical dam infrastructure (embankment, spillway, outlet pipeline, etc.), is normally monitored monthly with daily monitoring while the spillway is flowing.
- Horizontal and vertical movement is monitored annually at Newell Creek Dam.
- Periodic seismic reviews are conducted to ensure stability with respect to current seismic standards.

Additional mitigation strategies include updating of the Newell Creek Dam Emergency Action Plan (EAP), periodic updates to inundation mapping as new technology and downstream development occurs, and additions to the City's raw water sources.

10.4.1 Mitigation Goals

> **4.1 Local Hazard Mitigation Goals — Requirement §201.6(c)(3)(i):**
>
> The hazard mitigation strategy **shall** include a description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.

Dam Failure Goals:

Dam Failure 1 — Avoid or reduce the potential for life loss, injury, property or economic damage to Santa Cruz from dam failure.

Dam Failure 2 — Encourage mitigation activities that increase disaster resilience of the water system essential to a functioning City of Santa Cruz.

10.4.2 Identification and Analysis of Mitigation Actions

> **4.2 Identification and Analysis of Mitigation Actions — Requirement §201.6(c)(3)(ii):**
>
> The mitigation strategy **shall** include a section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure.

Dam Failure Mitigation Actions:

- The primary actions to mitigate the risk of dam failure are a careful monitoring program and the creation of redundancy in the water service infrastructure. (B-11).

CHAPTER 11: LANDSLIDE

11.3.0 Landslide Risk Assessment

11.3.1 Identifying Landslide Hazards

3.1 Identifying Hazards — Requirement §201.6(c)(2)(i):

The risk assessment **shall** include a description of the type, location, and extent of all natural hazards that can affect the jurisdiction.

The plan **shall** include information on previous occurrences of hazard events and on the probability of future hazard events.

Landslides are defined as the rapid downward movement of rock, earth or artificial fill on a slope. Factors causing landslides include the rock strength and orientation of elements on the slope, erosion, weathering, high rainfall, steepness of slopes, and human activities such as the removal of vegetation and inappropriate grading.

Landslide deposits and soil creep occur primarily on slopes in the western side of the city near Moore Creek Canyon. Deposits are also found in the upper portions of Arana Gulch and DeLaveaga Park and other isolated locations in the city.

Landslides are prevalent upstream of the city's drinking water intakes and affect production of potable water in many ways. Generally speaking, the impacts on drinking water production are the following:

- Elevated, persistent turbidity which requires increased treatment or source changes due the potential presence of pathogens in highly turbid water and total suspended solids (i.e., sand).
- Collateral damage on infrastructure and increased maintenance costs as pumps suffer sanding problems, basins fill with sand, pipelines burst from sediment deposition and flow changes, etc.

The raw water delivery system is also vulnerable to the risk of landslide. Loch Lomond Reservoir and a significant amount of the raw water system infrastructure are located in the Santa Cruz Mountains, some in areas that have experienced landslides. Because of this placement, the greatest threat to the City of Santa Cruz from landslides is in the Santa Cruz Mountains.[30]

Landslides occur in all U.S. states and territories. In a landslide, masses of rock, earth or debris move down a slope. Landslides may be small or large, slow or rapid. They are activated by:

- Storms
- Earthquakes

- Volcanic eruptions
- Fires
- Alternate freezing and thawing
- Alternate wetting and drying
- Increase in slope steepness by erosion or human modification

Debris and mud flows are rivers of rock, earth, and other debris saturated with water. They develop when water rapidly accumulates in the ground during heavy rainfall or rapid snowmelt, changing the earth into a flowing river of mud or "slurry." They can flow rapidly, striking with little or no warning at very high speeds. They also can travel several miles from their source, growing in size as they pick up trees, boulders, cars and other materials.

Landslide problems can also be caused by land mismanagement, particularly in mountain, canyons, and coastal regions. In areas burned by forest and brush fires, a lower threshold of precipitation may initiate landslides. Land-use zoning, professional inspections and proper design can minimize many landslide, mudflow, and debris flow problems.[31]

11.3.2 Profiling Landslide Hazard Events

A LOCATION

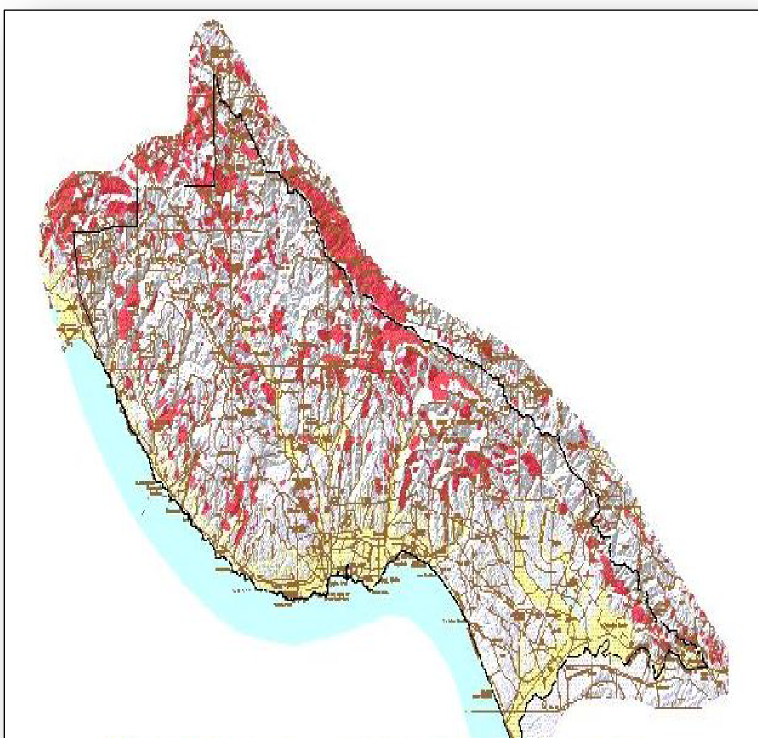


Figure 21 — Slides and earth flows in Santa Cruz County

Summary Distribution of Slides and Earth Flows in Santa Cruz County
by Carl M. Wentworth, Scott E. Graham, Richard J. Pike, Gregg S. Beukelman, David W. Ramsey, and Andrew D. Barron

Map Units

Mostly Landslide — Consists of mapped landslides, intervening areas typically narrower than 1,500 feet, and narrow borders around landslides; defined by drawing envelopes around groups of mapped landslides.

Many Landslides — Consists of mapped landslides and more extensive intervening areas than in 'Mostly Landslide'; defined by excluding areas free of mapped landslides; outer boundaries are quadrangle and County limits to the areas in which this unit was defined.

Few Landslides — Contains few, if any, large mapped landslides, but locally contains scattered small landslides and questionably identified larger landslides; defined in most of the region by excluding groups of mapped landslides but defined directly in areas containing the 'Many Landslides' unit by drawing envelopes around areas free of mapped landslides.

Flat Land — Areas of gentle slope at low elevation that have little or no potential for the formation of slumps, translational slides, or earth flows except along stream banks and terrace margins; defined by the distribution of surficial deposits

(*Wentworth, 1997*)

Source: See information below Fig. 21 (left) [USGS, undated]

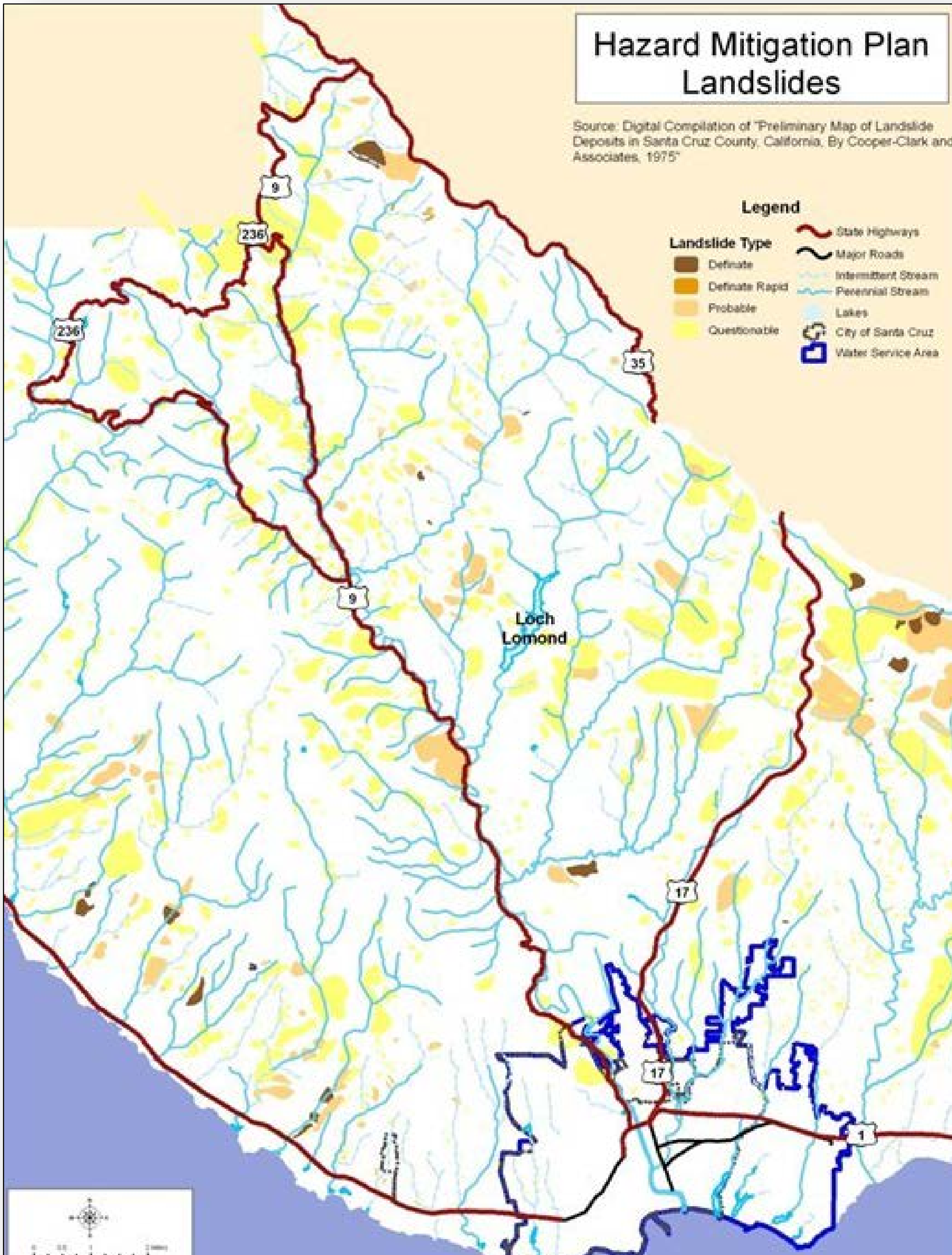


Figure 22 — Potential slide threats to Santa Cruz *Source*: (*see* map legend)

B EXTENT: MAGNITUDE OR SEVERITY

Landslides are a common occurrence in the Santa Cruz Mountains. Our intense winter storms, high rainfall amounts and steep terrain are all conducive to land sliding. Earthquake activity can add to the problem. The earthquake of 1906 set off dozens of large landslides in the Santa Cruz Mountains, some of which claimed human lives. The potential for loss of life and property is greater today due to the increase in population residing in areas of possible instability. However, new building and site design standards also reduce the risk for loss of life and property.

Although nature-caused landslides are beyond control, most recent landslides in the Santa Cruz Mountains have been caused by a combination of human activity and natural factors. Human activities which act to further destabilize slopes are logging, woodland conversion, road building, housing construction and any activity which alters normal drainage patterns. Whether or not any of these activities will trigger land sliding depends on the existing natural conditions. Some soil and rock types are more prone to land sliding than others. Landowners should determine the inherent geologic stability of their property before beginning construction activities.[32]

C PREVIOUS OCCURRENCES

The City of Santa Cruz Water Department has property, access rights of way, and infrastructure located in areas susceptible to land sliding.

The rainfall in winter 2017 was the cause of the most recent series of landslides and slope failures that resulted in leaks on several raw water transmission mains, culvert failures, and road failures.

Historical Record of Severe Landslides of Santa Cruz

January 1982
Severe storms caused multiple landslides affecting water pipelines and access roads. One landslide along Love Creek, west of Loch Lomond Reservoir, killed ten people. While this landslide was not on City-owned property and did not affect City-owned facilities, it was and continues to be an indicator of the potential severity of landslide activity and the need for observation and/or mitigation.

The City did experience less significant landsliding along the alignment of the Newell Creek pipeline north and south of Brackney Road, in Ben Lomond. To the south, a slide created a 5-foot high scarp which encroached to within a few feet of the pipeline. Two other landslides along this alignment occurred north of Brackney Road creating 2–5-foot scarps that extended from the outside edge of the access road towards the river.

Also associated with these storms were:

- Two landslides along the Laguna Creek pipeline alignment downstream of the trestle bridge crossing Laguna Creek; an 8-foot high scarp exposed and undercut the pipeline and,

- Smaller landslides also affected portions of the entrance and access roads to Loch Lomond Reservoir and nine separate slides occurred around the reservoir rim.

Loch Lomond East Bank Landslide

There are two landslides located along the east bank of the City's only raw water storage reservoir, Loch Lomond Reservoir. These landslides are referred to as the "ancient and recently active" landslides. The recently active landslide is contiguous with, and lies directly above the ancient landslide.

While it is postulated that movement in the recently active landslide was initiated in 1971 or earlier, movement of the recently active landslide was actually observed in 1980 and again in 1982. Formal study of the landslides began in 1980 with the installation of piezometers to quantify the recently active landslide, installation of tiltmeters in 1990 to observe movement in the recently active landslide, and the installation of inclinometers in 1992 to further the study of movement in both landslides.

Monitoring data collected in the spring of 2006 indicated that the recently active landslide appeared to have reactivated movement in the ancient landslide; however, movement in the ancient landslide has not been noted since that one single event in the spring of 2006.

The City continues to monitor the slide in accordance with various triggers including quarterly, after heavy rainfall events and following significant earthquakes.

The El Niño Winter Storms of 1998

The El Niño storms of 1998 caused multiple landslides affecting water pipelines and access roads. The area with the most damage occurred on the Laguna Creek Pipeline access road. The repair of the road required three retaining walls, grading and drainage at a cost of $525,000.

East Zayante Road

The City owns two parcels along East Zayante Road. Both parcels are subject to landsliding and/or debris flow due to various County and logging road cuts. In 2000, there was a debris flow from one of the locations onto the County Road. The City conducted a geotechnical paper study to provide initial recommendations on maintaining stable slopes. Due to the location, estimated probability of failure, and presumed damage in the event of a failure, the City has adopted an alternative that calls for periodic observations as opposed to a major structural repair. The latter alternative would be adopted should a significant change in conditions be noted.

Brackney Slide

This is an historic slide area through which the City's raw water pipeline from Loch Lomond is aligned. In 2002, the City installed multiple wye fittings on each end of two slide areas to facilitate temporary pipeline bypass connections should the area(s) slide away. The City's long-term Capital Improvement Program specifies replacement of the entire pipeline beginning in 2011/2012 and continuing to 2020 at a total projected cost of $13 million (2018–2020).

There is an additional $6.5 million allocated (in FY 2024 $1.5 million and FY 2025 $5 million) for additional replacement. Consideration will be given to realigning the pipeline to avoid historic slide areas.

Graham Hill Water Treatment Plant
One landslide occurred on the Graham Hill Water Treatment Plant property in April 2006. The slide was located entirely within an old fill wedge that was placed on the existing native slope. Repairs to this slide were completed in the fall of 2008.

Multiple slides due to severe winter storms (2017)

- **Parkway Headwalk at Allerton Street**
  The headwall was overtopped during storm causing damage to road and erosion into the downstream channel.
- **Pasatiempo Creek Open Concrete Channel at Ocean Street and Plymouth Street**
  The Channel overflowed causing erosion under the channel and lifted the channel's bottom concrete slab causing major damage to structural integrity of channel.
- **East Cliff at Alhambra**
  Storm induced slope failure adjacent to existing concrete sack wall.
- **East Cliff at Third Street Stairs Slope**
  Storm caused erosion of slope adjacent to, and under, stairs. Erosion east of stairs is impacting existing guard rail and sidewalk.
- **Esmeralda Court**
  Impacted by enormous amount of spring water this winter. During storm events springs surface through sidewalk and street paving section. Street has been spot repaired several times to eliminate hazards associated with street heaving.
- **Upper Park Road**
  Washout due to heavy rains. This road provides access to the City Emergency Operations Center.
- **West Cliff Drive Path**
  Washout due to heavy rains.

D PROBABILITY OF FUTURE EVENTS

Many water system facilities are located in remote areas of Santa Cruz County. Facilities such as water diversions are at the water sources which are often located in remote hilly or mountainous areas. Pipelines carrying water from the sources to the treatment facilities traverse hillsides, slopes and steep rugged terrain, much of which is prone to landslides.

11.3.3 Assessing Landslide Vulnerability: Overview

3.3 Assessing Vulnerability: part 2 Overview — Requirement §201.6(c)(2)(ii): The risk assessment **shall** include a description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description **shall** include an overall summary of each hazard and its impact on the community.

Past experience has shown that the water system is very vulnerable to landslides. While there could be significant expense involved in replacing landslide damaged infrastructure, there is also the risk of water outages caused by landslide events.

A OVERALL SUMMARY OF VULNERABILITY TO LANDSLIDE

The urban center of Santa Cruz is unlikely to experience landslides although they do occur on steeper slopes within the City and can cause significant damage. However, the greatest vulnerability from landslide to the City of Santa Cruz is to the city water system.

The majority of the water storage and infrastructure for delivering water to the community is outside the city limits in mountainous terrain. The storage facilities, pipelines and treatment plants are vulnerable to landslide and have experienced landslides in the past.

11.3.4 Assessing Vulnerability: Identifying Structures

3.4 Assessing Vulnerability: Identifying Structures — Requirement §201.6(c)(2)(ii)(A): The plan **should** describe vulnerability in terms of the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard area.

Landslides threaten relatively few buildings and residences. The potential losses are to water storage, treatment and transport facilities and the impacts of these losses on the City of Santa Cruz water system consumers.

A TYPES AND NUMBERS OF EXISTING BUILDINGS, FACILITIES AND INFRASTRUCTURE

- Laguna Dam
- Laguna Pipeline (from dam to Highway 1)
- Liddell Spring

- Liddell Pipeline (from spring box to Highway 1)
- Majors Dam
- Majors Pipeline (from dam to Highway 1)
- Coast Pipeline (Highway 1 to the Coast Pump Station)
- Loch Lomond Reservoir (impounded by Newell Creek Dam)
- Newell Creek Pipeline
  (from Newell Creek Dam to the Graham Hill Water Treatment Plant)

11.3.5 Assessing Vulnerability: Estimating Potential Losses

3.5 Assessing Vulnerability: Estimating Potential Losses — Requirement §201.6(c)(2)(ii)(B):

The plan **should** describe vulnerability in terms of an estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(i)(A) of this section and a description of the methodology used to prepare the estimate.

Table 11-1 Landslide Potential Loss By Structure

Facilities	Location	Costs
Laguna Dam		unknown
Laguna Pipeline	Dam to Highway 1	$350 per linear foot
Liddell Pipeline	Spring box to Highway 1	$350 per linear foot
Majors Dam		unknown
Majors Pipeline	Dam to Highway 1	$350 per linear foot
Coast Pipeline	Highway 1 to Coast Pump Station	$520 per linear foot
Loch Lomond Reservoir	Santa Cruz Mountains	unknown
Newell Creek pipeline	Dam to Graham Hill Water Treatment Plant	$520 per linear foot

B METHODOLOGY USED TO PREPARE ESTIMATE

Valuation:
Engineer’s Estimate

Population:
The entire community of Santa Cruz as well as surrounding water service areas is at risk if there is damage to the water supply.

11.3.6 Assessing Vulnerability: Analyzing Development Trends

3.6 Assessing Vulnerability: Analyzing Development Trends — Requirement §201.6(c)(2)(ii)(C): The plan **should** describe vulnerability in terms of providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.

A DESCRIPTION OF LAND-USES AND DEVELOPMENT TRENDS

Santa Cruz is a compact urban City surrounded by mountains, greenbelt and the Pacific Ocean. The size of the water service area has remained constant over time due to a policy prohibiting water main extensions to unserved areas and the acquisition of open space lands which creates a greenbelt around the City that serves to inhibit urban sprawl. Accordingly, any growth and redevelopment that will occur in the future is expected to be concentrated within the confines of the existing service area boundary.

Within the City of Santa Cruz, only a small amount of land remains undeveloped. Because of the relative scarcity of raw land, the majority of future growth in the area is likely to be achieved through redevelopment, remodeling, infill and increased density on underutilized land, along with new construction on the little amount of vacant land remaining. In other words, the service area has been fixed (not growing outward).[33]

The City of Santa Cruz water system currently serves approximately 90,000 people and is anticipated to grow to 100,000 by 2030. This number does not include additional University growth.[34]

The University of California at Santa Cruz has included significant growth numbers in its Long Range Development Plan (LRDP). While there is no specific mention of additional landslide hazards should there be the anticipated growth, the following excerpts from the LRDP do discuss issues related to topography, earthquake and liquefaction and new development. It also notes that additional environmental review would precede new development.

From the LRDP (page 35)

Topography

Topography is a determining factor in the development of the UC Santa Cruz campus. It presents a clear structure that creates the drama of the landscape and directs past and future campus development. From the main entrance at the south, the land elevation rises nearly 900 feet to the far north end of the campus in a series of stepped terraces. Several drainages have scoured ravines down the slope, which divide the central and south campus into three zones in the east/west direction. In places at Moore Creek, Jordan Gulch, and Cave Gulch, these ravines are as much as 70 feet deep and 350 feet wide. The

> combination of the terraced land and the ravines make the campus setting unique and poses particular challenges for circulation and siting of development.

and, (page 37)

> Although campus bedrock is highly faulted, there is no evidence that these faults have been active since Holocene times (within the last 10,000 years). Earthquake fault rupture and soil liquefaction are not considered campus geologic hazards. (Emphasis added).

and, (page 68)

> **CAMPUS RESOURCE LAND (CRL)**
>
> The 1988 LRDP assigned approximately 471 acres of undeveloped land located in the northern part of the campus to this land-use category. The 2005 LRDP land-use plan designates 335 acres of undeveloped land, mainly located in the far north campus and areas in the coastal zone west of Empire Grade and west of Porter College, to this land-use category. This land-use designation is assigned to lands that are not planned for development under the 2005 LRDP. It is envisioned that these lands would be maintained in their natural state to serve as long-term reserve lands for future use. In the event that the campus determines during the term of the 2005 LRDP that it needs to develop some portion of this land, it will conduct additional environmental review and will seek an LRDP amendment. (Emphasis added).

11.4.0 Mitigation Strategy

4.0 Mitigation Strategy — Requirement §201.6(c)(3): The plan **shall** include a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs and resources, and its ability to expand on and improve these existing tools.

11.4.1 Mitigation Goals

4.1 Local Hazard Mitigation Goals — Requirement §201.6(c)(3)(i): The hazard mitigation strategy **shall** include a description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.

Landslide Goals:

Landslide 1 — Avoid or reduce the potential for life loss, injury, property and economic damage from landslide hazards.

Landslide 2 — Protect the Santa Cruz water system and infrastructure from landslides including improvement in water system redundancy planning for continuous service.

11.4.2 Identification and Analysis of Mitigation Actions

4.2 Identification and Analysis of Mitigation Actions — Requirement §201.6(c)(3)(ii):

The mitigation strategy **shall** include a section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure.

Landslide Mitigation Actions:

- Protect Water System infrastructure through landslide monitoring (A-13)

The Landslides Hazard Program[35]

The enormous damages from landslides can be reduced. The primary objective of the National Landslide Hazards Program (LHP) is to reduce long-term losses from these hazards by improving our understanding of the causes of ground failure and suggesting mitigation strategies.

The LHP has operated since the mid-1970s in gathering information, conducting research, responding to emergencies and disasters and producing scientific reports and other products for a broadly based user community. The LHP publishes results of its investigations in various outlets for use by geologists and engineers in government, by those in academia and in private practice, by planners and decision makers from governmental entities at all levels, and the general public.

The results of these efforts have led to significant improvements in understanding the nature and scope of ground-failure problems nationally and worldwide. Such improvements are central to the role of the program because opportunities remain for fundamental advances in understanding that promise to save lives and dollars.

Hazard Mitigation Monitoring

The Water Department monitors the Loch Lomond East Bank Landslide quarterly as well as after significant rain or earthquake events through a set of 5 inclinometers and 10 piezometers.

After monitoring Loch Lomond East Bank Landslide for twenty years, and noting that the likelihood is low that the “recently active landslide” will suddenly slide into the reservoir with enough energy to generate a wave of sufficient amplitude to overtop Loch Lomond Dam, the

Water Department evaluated the current monitoring program in fall of 2012. The evaluation determined that the department will continue monitoring the ancient landslide only, which is located above the more recently active landslide. Monitoring data collected in the spring of 2006 indicated possible movement in the ancient landslide; however, movement in the ancient landslide has not been noted since that one single event in the spring of 2006.

Due to the significant monetary and environmental expense to relocate water system facilities and the uncertainty of specific locations affected by slide events, the Water Department's strategy for minimizing loss of water service due to a slide event is to improve water system redundancy. By developing multiple water sources, treatment facilities, and storage facilities, the risk of total outages is reduced due to loss of a facility.

The Water Department has installed wye valves on each side of the Brackney Slide to facilitate installation of temporary pipe in the event of a slide. The Water Department's Long Term Capital Improvement Program calls for improvements in storage tank redundancy, replacement of pipelines and additional water supply augmentation over the next 10 years.

CLIMATE ADAPTATION CONSIDERATIONS

Landslides were not called out specifically as a climate change related vulnerability in the 2011 Climate Adaptation Plan. However, in the 2017 Climate Action Plan Update, landslides are — including as a vulnerability — since protecting the city water system infrastructure from erosion and landslides is noted in many of the 2011 Plan's high priority action items. Furthermore, increases in storm intensity and duration, a potential impact from climate change, may exacerbate the potential for landslides.

CHAPTER 12: MULTI-HAZARD SUMMARY

Any of the hazards that threaten Santa Cruz could happen in combination with another hazard. In fact, there is a high likelihood that a major earthquake on the San Andreas or other faults would unleash secondary hazards that could be as disastrous to Santa Cruz as the earthquake itself. An unforgettable reference point for the Bay Area is the devastating fire in 1906 that burned down San Francisco, causing significantly more destruction than the earthquake that sparked it.

Earthquakes have started fires or caused other, secondary disasters throughout history. Within the recent past, one example is the 1995 Kobe, Japan earthquake. Another is the March 2011 Japanese earthquake resulting in a devastating tsunami and nuclear facility crisis. Earthquake shaking can start fires in numerous ways, such as tipping over appliances with pilot lights or damaging electrical equipment leading to sparks. Ruptured gas lines, both underground and where they connect to houses, or spilled flammable chemicals can cause post-earthquake fires to spread quickly. Efforts to fight fires after an earthquake are often severely hampered by non-functional water systems, damaged electrical systems that are needed to provide energy to pump water, or roads blocked by debris or landslides. These problems coincide with fire personnel being required for search and rescue activities and other disaster response activities.

Santa Cruz has experienced landslides during earthquakes and recent (2017) severe storms. These may be repeated occurrences, particularly if the earthquake occurs during rainy winter months. Small aftershocks could continue to cause slides for weeks after a quake, blocking roads and damaging homes. In addition, the next earthquake may cause significant damage to the city's water supply, located in a mountainous slide prone areas, and storm drain systems.

Although the risk is very low, an earthquake has the potential to cause dam failure. Breaks in the dams, levees and stream culverts could lead to catastrophic flooding in areas that have not seen floodwaters previously.

Drought increases the risk of wildfires, and wildfires increase the risk of landslide and flood. When all supporting vegetation is burned away, hills become destabilized and prone to erosion. The charred surface of the earth becomes hard and absorbs less water during rainfall, leading to increased runoff resulting in more rapid coastal erosion.

Many mitigation activities reduce risk from more than one hazard. However, there are some mitigation activities that reduce risk from one possible threat while increasing it from another. One example is placing utility lines underground. While underground utilities are less damaged by a major fire than those above ground, in an earthquake, underground utilities in areas prone to landslides or liquefaction are susceptible to damage and are more costly and time-consuming to repair than above ground utilities. Another example of mitigation with positive and negative impacts is vegetation removal for wildfire risk reduction. Trees and other established plants play a key role in securing hillsides and reducing landslide risk. They reduce erosion and slow rain runoff time, thus reducing flood peaks.

It is important to remember all of the implications of any risk reduction steps when planning mitigation activities.

PART 4 – MITIGATION STRATEGY

Mitigation Strategy

- Goals
- Objectives
- Actions

CHAPTER 13: MITIGATION STRATEGY

4.4.0 Mitigation Strategy

4.0 Mitigation Strategy: — Requirement §201.6(c)(3): The plan **shall** include a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs and resources, and its ability to expand on and improve these existing tools.

The City of Santa Cruz endeavors to be a disaster-resistant community that can survive and recover from a disaster while preserving the diversity and quality of its natural and built environments. The community strives to offer excellent cultural and community services as well as maintain and improve infrastructure, community safety and emergency preparedness. This Local Hazard Mitigation Plan is a part of this effort.

The City of Santa Cruz has developed a range of policies and programs to act as a "blueprint" for the hazard mitigation strategy. Strategies include "everyday operations" that also contribute to reducing the impact of future hazards as well as specific hazard mitigation projects. While City efforts are focused on evaluation and improvement of City-owned structures, particularly those identified as critical facilities, the plan also encourages the establishment of standards to encourage private property owners to upgrade the hazard resistance of their own properties. And, the City is actively engaged with other local and regional organizations to collaboratively work towards mitigation actions that meet the City of Santa Cruz' objective of being a disaster resistant community while striving to preserve the quality of its natural and built environments.

This plan focuses on mitigation goals and actions, meaning activities that occur prior to a hazard event that reduce or avoid damage when disasters strike. Damage prevention includes structural improvements to existing buildings, land use decisions that will minimize damage and ongoing programs such as vegetation reduction in wildland/urban interface areas.

This plan does not include emergency response activities. The City of Santa Cruz has an Emergency Operations Plan (EOP) that details the City's concept of operations in response to disasters. The EOP outlines how information and resources are coordinated for disasters or threat of disasters. The City's Emergency Operations staff (OES/Analyst) endeavors to conduct annual trainings, tabletop exercises and other drills and trainings that support the preparedness and response capabilities of City staff as well as the readiness of the Emergency Operations Center. Information updates and tabletop discussions are conducted to clarify staff roles and responsibilities in the EOC, in the Department Operations Centers (DOCs) and in the field to help protect people and property. This EOP is attached as Appendix O.

GOALS

Goals are general guidelines that explain what is to be achieved. They are usually broad-based, policy-type statements, long-term and represent global visions. Goals help define the benefits that the plan is trying to achieve. The success of the LHMP, once implemented, should be measured by the degree to which its goals have been met and the actual, resulting benefits in terms of hazard mitigation that occurs.

The original and subsequent LHMP Project Teams (2007, 2012) held several meetings to review the identified risks and developed goals, objectives and actions based on the most recent risk assessments. Goals which provided the greatest benefit in hazard reduction were identified as primary goals. This plan update continues the collaborative effort of city staff and key stakeholders that have reviewed the plan.

Goals specifically related to each identified potential hazard are presented under each hazard heading.

The Local Hazard Mitigation Plan has four primary mitigation goals:

1. Avoid or reduce the potential for life loss, injury and economic damage to Santa Cruz residents from hazard events;
2. Increase the ability of city government to serve the community during and after hazard events;
3. Protect the unique character, scenic beauty and values in the natural and built environment from being compromised by hazard events;
4. Encourage mitigation activities to increase the disaster resilience of institutions, private companies and systems essential to a functioning City of Santa Cruz.

OBJECTIVES

The LHMP team selected the objectives listed below to meet multiple goals. They remain as the goals of this 2018–2023 Plan Update. The objectives serve as a stand-alone measurement of a mitigation action rather than as a subset of a goal. Achievement of the objectives is a measure of the effectiveness of a mitigation strategy. The objectives are also used to help establish priorities.

Objectives are defined as short-term aims which, when combined, form a course of action to meet a goal. Unlike goals, objectives are specific and measurable.

The Local Hazard Mitigation Team identified this list of objectives:

1. Consider the impacts of hazards on future land use decisions in the city by coordinating with other planning mechanisms including the General Plan and land use code development.
2. Protect and sustain reliable local emergency operations and communication facilities during and after disaster.

3. Develop new, or enhance existing, early warning response systems
4. Seek to enhance emergency response capabilities through improvements to infrastructure and City programs
5. Seek mitigation projects that provide the highest degree of hazard protection at the least cost
6. Seek to update information on hazards, vulnerabilities, and mitigation measures by coordinating planning efforts and creating partnerships with appropriate local, county, state, and federal agencies
7. Seek to implement codes, standards, and policies that will protect life, property and quality of life including environmental, historic and cultural resources from the impacts of hazards within the City of Santa Cruz
8. Educate the community on preparedness for, and mitigation of, potential impacts of hazards to the City of Santa Cruz
9. Encourage retrofit, purchase, or relocation of structures in high hazard areas, including those known to be repetitively damaged

Identification and Analysis of Mitigation Actions

IDENTIFICATION OF ACTIONS

The local hazard mitigation goals are enumerated above. In support of those goals, the City of Santa Cruz has identified a number of hazard mitigation actions. During the development of the original LHMP, this set of actions was developed through an inclusive community process. The LHMP team, with input from the General Plan Update, Emergency Operations Plan, Capital Improvement Program, Urban Water Management Plan as well as other agencies, UCSC representatives and community members, has selected the following actions as the most beneficial for the City of Santa Cruz. These actions represent the highest priority mitigation actions identified for each hazard or for a multi-hazard event.

These mitigation actions have proven effective in reducing or eliminating hazard risk. Each of these actions directly meets an objective or goal listed in the City of Santa Cruz Local Hazard Mitigation Strategy. These actions are not meant to be exhaustive but rather to inspire thought and provide each department of the City of Santa Cruz with a role in hazard mitigation and a baseline of actions backed by a planning process, consistent with the goals and objectives and within the capabilities of the City. City departments were not bound to the list of alternatives presented. They were given the opportunity to edit the list. Actions not included in the action plan were eliminated based on the following:

- Action is currently outside the scope of the defined priority rankings
- City's jurisdiction is not vulnerable to the hazard
- Action has already been implemented
- Estimated cost exceeded estimated benefit

Prioritization of Actions

The list below summarizes all of the identified actions, identifies the hazard(s) each one addresses, and indicates the assigned priority level of the action. The actions were prioritized in the same way that they were identified. The team leaders proposed an initial prioritization system, dividing the actions into categories of *Very High Priority*, *High Priority*, and *Important*.

City staff, Council members, commission(s) and community members were given an opportunity to review these categorizations.

Many factors were considered when assigning priorities. First, only those actions with strong community support were given *Very High* or *High* priority ratings. Second, addressing those hazards presenting the highest risk to Santa Cruz was given priority. The loss estimates in this Plan show that earthquakes, floods and tsunamis have the most potential to cause great economic and human losses. Water is essential to the survival of the City so drought and threats to the water system were also ranked as *High* or *Very High* priority. Finally, availability of funding (identified in the Capital Improvement Program or other source) was a determining factor in priority determination.

Section 201.c.3.iii of Title 44 of the Code of Federal Regulations requires that an action plan describe how actions identified were prioritized. The planning team has developed a prioritization methodology for the action plan that meets the needs of the City while at the same time meeting the requirements of Section 201.6 of Title 44 of the Code of Federal Regulations. The mitigation strategies identified were prioritized according to the criteria defined below.

Very High Priority

- A project that meets multiple plan objectives
- Benefits exceed cost
- Has strong community support
- Addresses those hazards presenting the highest risk exposure to life and property and the environment
- Funds are identified or potentially available
- Project can be completed in one to five years once project is funded

High Priority

- Project meets at least one plan objective
- Benefits exceed costs
- Funding has not been secured
- Project can be completed in one to five years once project is funded

Important

- Project mitigates the risk of a hazard
- Benefits exceed costs
- Funding has not been identified and/or timeline for completion is considered long-term (five to ten years)

A formal cost benefit analysis has not been done. However, in reviewing the mitigation actions proposed, the costs and benefits of each action were considered under the following rating:

Funding Considerations — Cost ratings

High	Existing funding levels are not adequate to cover the costs of the proposed project and would require an increase in revenue through an alternative source (for example, bonds, grants, and fee increases) to implement.
Medium	The project could be implemented with existing funding but would require a re-apportionment of the budget or a budget amendment, or the cost of the project would have to be spread over multiple years.
Low	The project could be funded under the existing budget. The project is part of, or can be part of, an existing, ongoing program.

Benefit ratings

High	Project will have an immediate impact on the reduction of risk exposure to life and property
Medium	Project will have a long-term impact on the reduction of risk exposure to life and property or project will provide an immediate reduction in the risk exposure to property
Low	Long-term benefits of the project are difficult to quantify in the short term

In recent years, and in response to the 1989 Loma Prieta Earthquake, the City of Santa Cruz has made significant progress through efforts to reduce risk in public buildings, fire stations, major municipal facilities and public schools. This updated plan will continue these efforts and expand upon them throughout the community. These efforts will protect future generations from the devastation of natural hazards experienced by the residents of Santa Cruz in the past.

The City will pursue the implementation of these actions to meet the goals set out above. The *Very High* and *High* priority actions will be conducted actively as funding becomes available. The following Action lists have been updated (2018).

Revisions to these following Mitigation Actions (i.e., changes from prior versions) are shown in red, bold font.

Items that are continued from the prior LHMP are noted as “ongoing.” Changes indicate either new actions, updates to department responsibility, or other changes to action planning and progress.

A = Very High Priority Action

	Action	Hazard	Department	Timeline
A-1	Establish pre-event planning for post-disaster recovery as an integral element of the Emergency Operations Plan of the City Council and each of the City departments including ongoing staff training	Multi-hazard	Emergency Operations; All City Departments	ongoing
A-2	Coordinate preparedness efforts with Santa Cruz County Office of Emergency Services, UCSC and other cities and agencies in the region	Multi-hazard	Emergency Operations	ongoing
A-3	Educate and inform the community about emergency preparedness options in the event of a hazard event; **including meeting the guidelines and becoming recognized as a Tsunami Ready community**	Multi-hazard	Emergency Operations; Public Information Officer(s)	ongoing
A-4	Ensure completeness and availability of identified emergency supplies such as water main repair parts, road clearing equipment, sandbags, medical and communications equipment	Multi-hazard	Emergency Operations; Water; Public Works; Fire; ~~**Planning and**~~ Building	ongoing
A-5	~~**Enhance cellular services to critical facilities.**~~ **Add repeaters as needed to enhance cellular services to critical facilities**	Multi-hazard	Emergency Operations	ongoing
A-6	Encourage mitigation activities to increase the disaster resilience of institutions, private companies and systems essential to a functioning Santa Cruz	Multi-hazard	Planning and Building; Emergency Operations	ongoing
A-7	Continue cooperative/merged fire protection agreements with UCSC, the County fire districts and the California Department of Forestry	Wildfire	Fire; City Manager; [UCSC]	ongoing
A-8	Increase efforts to reduce fire risk in existing development and in wildland/urban interface areas particularly steep canyons and arroyos through improved vegetation management and appropriate code enforcement	Wildfire	Fire; Water; Planning and Building	ongoing
A-9	Review open space land use to reduce incidence of human caused wildfire	Wildfire	Fire; Parks and Recreation; Police; Public Works	ongoing

	Action	Hazard	Department	Timeline
A-10	Require upgrade of sewer, water and other infrastructure to withstand seismic shaking and differential settlement	Earthquake	Public Works; Planning and Building; Water	ongoing
A-11	~~**Reduce near term drought shortages through water conservation and curtailment of water use**~~. **Reduce impacts of drought-related water shortages through increased water conservation activities and, if necessary, implementation of Water Shortage Contingency Plan**	Drought	Water	ongoing
A-12	~~**Provide a reliable water supply that meets long term needs while insuring protection of public health and safety in the form of seawater desalination facility**~~. Provide significant improvement to the sufficiency and reliability of the Santa Cruz water supply by 2025 though passive or active recharge of regional aquifers	Drought	Water	3–5 years
A-13	Protect water system infrastructure and reservoir from landslides **and other failure— landslide monitoring and stabilization**	Landslide	Water	ongoing
A-14	**Reduce risk of damage to water system infrastructure along San Lorenzo River**	**Flood**	**Water**	ongoing

B = High Priority Action

	Action	Hazard	Department	Timeline
B-1	Periodically review structural integrity of bridges connecting the City's transportation routes	Multi-hazard	Public Works; [Caltrans]	ongoing
B-2	Protect and preserve coastline and infrastructure through permit review	Coastal Erosion	Public Works; Planning and Building	ongoing
B-3	Protect and preserve coastline and infrastructure through coastal restoration efforts — West Cliff Drive	Coastal Erosion	Public Works; Parks and Recreation	ongoing **dependent on funds and as emergencies happen**

	Action	Hazard	Department	Timeline
B-4	Ensure early warning system for evacuation of areas susceptible to natural flooding, tsunami inundation, seiches or dam failure.	Flood**;** Tsunami	Emergency Operations; Police; Fire; **Water**	ongoing
B-5	Regulate development in floodplains and increase public awareness of flood hazards	Flood**;** Tsunami	Planning and Building; Public Works	ongoing
B-6	Encourage property owners, potential buyers and residents living in floodplains and coastal inundation areas to participate in Federal Flood Insurance Program	Flood**;** Tsunami	Planning and Building	ongoing
B-7	Reduce flooding hazards potential flood areas along Branciforte and Carbonera Creeks.	Flood	Public Works	ongoing
B-8	Rehabilitate **and add to** the City's storm drain system to reduce local flooding caused by inadequate storm drainage	Flood	Public Works	ongoing
B-9	Continue programs that promote installation, inspection, and testing of built-in fire extinguishing and early warning alarm systems	Wildfire	Fire; Planning and Building	ongoing
B-10	Abate hazardous conditions when identified and create program**s** that are proactive not reactive	Wildfire	Fire; Parks and Recreation; Police	ongoing
B-11	~~**Dam monitoring – conduct monthly piezometer monitoring at Newell Creek Dam.**~~ **Monitor Newell Creek Dam and infrastructure to preserve water resources and minimize risks to people and property resulting from dam failure; Replace or rehabilitate inlet/outlet works to meet Division of Safety of Dams operational requirements.**	Dam Failure	Water; [outside agencies]	ongoing
B-12	**Flood control maintenance on San Lorenzo River**	**Flood**	**Public Works**	ongoing

C = Important Action

	Action	Hazard	Department	Timeline
C-1	Encourage and support the protection of cultural, historic and architecturally significant structures to preserve neighborhood and community character	Multi-hazard	Planning and Building; Parks and Recreation	ongoing

	Action	Hazard	Department	Timeline
C-2	Update and enhance GIS systems and mapping for all hazards in the City	Multi-hazard	Information Technology; Economic Development	1–2 years
C-3	Appraise City-owned, **information technology** infrastructure for critical facilities	Multi-hazard	Information Technology; Economic Development	2–3 years
C-4	Discourage locating public facilities (other than those associated with open space uses) and above-ground utilities in high fire hazard areas	Wildfire	Fire**;** ~~**Planning and Building**~~	ongoing
C-5	Identify potential funding mechanisms to obtain fuel reduction grants	Wildfire	Fire	5–7 years
C-6	Continue programs to promote fire safety prevention programs for the schools, high occupancy institutional uses and commercial industrial	Wildfire	Fire	ongoing
C-7	~~**Global warming**~~ Climate Change	Multi-hazard	Planning; City Manager	ongoing
C-8	Complete the ongoing efforts to retrofit all remaining non-complying unreinforced masonry buildings during repair or alteration including risk reduction from lateral spreading	Earthquake	Planning and Building	ongoing
C-9	Working with appropriate agencies, upgrade the structural safety of all existing emergency use and critical structures, such as medical facilities, schools, police and fire stations and emergency response centers as necessary and appropriate	Multi-hazard	Planning and Building	5–7 years
~~**C-10**~~	~~**Flood control maintenance on San Lorenzo River**~~ **(see B-12)**	~~**Flood**~~	~~**Public Works**~~	~~**ongoing**~~

All of the above mitigation actions identified by the City of Santa Cruz are presented below with suggestions for implementation, identification of lead departments in the City, preliminary estimates of resources required and timelines. These have been reviewed and updated (2018).

	Very High Priority Actions
A-1	**Hazard event planning**
Proposed Activities	Establish pre-event planning for post-disaster recovery as an integral element of the Emergency Operations Plan in all City departments including ongoing training.
Hazard	All
Environ Concerns	None
Lead Department	Emergency Operations/**Fire**; Operational Departments
Timeline	**Ongoing**
Resources Required	Unknown staff time
Funding Source	Regular staff salaries
Priority	Very high
A-2	**Emergency preparedness coordination**
Proposed Activities	Coordinate preparedness efforts with Santa Cruz County Office of Emergency Services, UCSC, and other cities and agencies in the region
Hazard	All
Environ Concerns	None
Lead Department	Emergency Operations/**Fire**; City Manager's Office
Timeline	**Ongoing**
Resources Required	Unknown staff time
Funding Source	Regular staff salaries
Priority	Very high
A-3	**Community emergency preparation education**
Proposed Activities	Educate and inform the community about emergency preparedness options for hazard events
Hazard	All
Environ Concerns	None
Lead Department	Emergency Operations/**Fire**
Timeline	**Ongoing**
Resources Required	Staff time, materials production; website page development; social media
Funding Source	Staff salary
Priority	Very high

	Very High Priority Actions
A-4	**Emergency supply preparedness**
Proposed Activities	Ensure completeness and availability of identified emergency supplies such as water main repair parts, generators, pumps, sandbags, road clearing, medical and communications equipment
Hazard	All
Environ Concerns	None
Lead Department	Emergency Operations/**Fire**; Operational Departments
Timeline	**Ongoing**
Resources Required	Significant funds required to stock supplies
Funding Source	Water Fund, General Fund, ~~**some**~~ unidentified outside funding
Priority	Very high
A-5	**Cellular services**
Proposed Activities	~~**Enhance cellular service to critical facilities**~~**. Add repeaters when needed to enhance cellular service to critical facilities**
Hazard	All
Environ Concerns	Community concerns re: placement of cell towers
Lead Department	Emergency Operations**/Fire**; **Information Technology**
Timeline	**Ongoing** acquisition as needed
Resources Required	Outside funding — mutual aid during hazard events
Funding Source	General Fund — unidentified grants
Priority	Very high
A-6	**Encourage disaster resilience**
Proposed Activities	Encourage mitigation activities to increase the disaster resilience of institutions, private companies and systems essential to a functioning Santa Cruz through public outreach efforts and regulatory requirements.
Hazard	Multi-Hazard
Environ Concerns	Economic disruption
Lead Department	Planning and Building
Timeline	**Ongoing**
Resources Required	Unknown staff time for public outreach
Funding Source	Permit fees and unidentified grant funds
Priority	Very high
A-7	**Maintain cooperative agreements**
Proposed Activities	Continue cooperative fire protection agreements with UCSC, the County fire districts and the California Department of Forestry
Hazard	Wildfire
Environ Concerns	None
Lead Department	Fire
Timeline	**Ongoing**
Resources Required	Minimal administrative staff time
Funding Source	General Fund — regular staff
Priority	Very high

	Very High Priority Actions
A-8	**Vegetation management**
Proposed Activities	Increase efforts to reduce fire risk in wildland/urban interface; particularly steep canyons and arroyos through improved vegetation management and appropriate code enforcement
Hazard	Wildfire
Environ Concerns	Vegetation Management Plan approval
Lead Department	Fire; Parks and Recreation; **Water**
Timeline	**Ongoing**
Resources Required	Staff time; outside consultant services — funding
Funding Source	Staff budget and unidentified outside grants
Priority	Very high
A-9	**Open space monitoring**
Proposed Activities	Review and revise usage of open space to reduce incidence of human caused wildland fire
Hazard	Fire
Environ Concerns	Vegetation Management Plan approval
Lead Department	Fire; Parks and Recreation; Public Works; Police
Timeline	**Ongoing**
Resources Required	Additional assigned staff in all relevant departments
Funding Source	Staff budget and unidentified outside funding required
Priority	Very high
A-10	**Upgrade infrastructure for seismic shaking**
Proposed Activities	Require upgrade of sewer, water and other infrastructure to withstand seismic shaking and differential settlement
Hazard	Earthquake
Environ Concerns	None
Lead Department	Planning and Building; Public Works; **Water**
Timeline	Ongoing based on current standards
Resources Required	Staff time and unknown funds
Funding Source	State and federal grants, General Fund, building fees
Priority	Very high
A-11	**Conservation and Curtailment**
Proposed Activities	~~**Reduce near term drought shortages through conservation and curtailment of water use**~~**. Reduce impacts of drought-related water shortages through increased water conservation activities and, if necessary, implementation of Water Shortage Contingency Plan.**
Hazard	Drought
Environ Concerns	None
Lead Department	Water
Timeline	Ongoing through ~~**2020**~~ 2035
Resources Required	$500,000 per year
Funding Source	Water Fund; Water System Development Fees Fund
Priority	Very high

	Very High Priority Actions
A-12	**~~Desalination facility~~ Water Supply Reliability**
Proposed Activities	**~~Provide a reliable water supply that meets long term needs while insuring protection of public health and safety in the form of a seawater desalination facility~~. Provide significant improvement to the sufficiency and reliability of the Santa Cruz water supply by 2025 though passive or active recharge of regional aquifers.**
Hazard	Drought
Environ Concerns	**~~Marine impacts, energy consumption, growth inducement~~. Water quality**
Lead Department	Water — in conjunction with **Scotts Valley Water District**, Soquel Creek Water District, **Santa Cruz Mid-County Groundwater Agency and Santa Margarita Groundwater Basin Advisory Committee**
Timeline	Estimated time to be operational **~~2012–2014~~ 2025 (tentative 2020 decision point)**
Resources Required	Over **~~$60~~** $100 million; external funding required, grants and bond financing
Funding Source	Water Fund; Water System Development Fees Fund; **3–5 FTE City staff** plus team of outside technical consultants (engineering and environmental)
Priority	Very high
A-13	**~~Protect water system infrastructure~~. Rehabilitate/replace water system infrastructure**
Proposed Activities	Protect water system infrastructure and reservoir from landslides and other failure **~~through water system~~** — landslide monitoring and slope stabilization
Hazard	Landslide, earthquake, liquefaction, **flooding**
Environ Concerns	Geologic and hydrologic
Lead Department	Water
Timeline	**Ongoing**
Resources Required	External funding required; from **~~$0.5–$2.0~~** $5–$10 million per year; **~~1.5 FTE~~ City staff** plus outside consultants (geologists, geotechnical and civil engineers**~~, environmental~~**)
Funding Source	Grants, Water Fund and Water System Development Fees Fund
Priority	Very high

	Very High Priority Actions
A-14	**Rehabilitate/replace water system infrastructure**
Proposed Activities	**Reduce risk of damage to water system infrastructure along San Lorenzo River**
Hazard	**Flood**
Environ Concerns	**Hydrologic**
Lead Department	**Water**
Timeline	**Ongoing**
Resources Required	**External funding required; from $500K to $3 million per project; City staff plus outside consultants**
Funding Source	**Grants, Water Fund and Water System Development Fees Fund**
Priority	**Very high**

	High Priority Actions
B-1	**Bridge integrity check**
Proposed Activities	Periodically review structural integrity of bridges connecting the ~~c~~**C**ity's transportation routes
Hazard	Flood, Earthquake, Tsunami, Dam failure, Multi-hazard
Environ Concerns	None
Lead Department	Public Works; Inspections done by Caltrans
Timeline	Every two years
Resources Required	Some City staff time
Funding Source	Caltrans funding
Priority	High
B-2	**Protect and preserve coastline**
Proposed Activities	Protect and preserve coastline and existing infrastructure through permit review
Hazard	Coastal erosion
Environ Concerns	Coastal Commission review and some community concerns regarding alteration of coastline
Lead Department	Planning and Building
Timeline	**Ongoing**
Resources Required	Staff time
Funding Source	Permit fees
Priority	High

	High Priority Actions
B-3	**Protect coastline and infrastructure**
Proposed Activities	Protect and preserve coastline and infrastructure through coastal restoration efforts
Hazard	Coastal erosion
Environ Concerns	Coastal Commission review and some community concerns regarding alteration of coastline
Lead Department	Public Works; Parks and Recreation
Timeline	**Ongoing** and event driven
Resources Required	Staff time
Funding Source	FEMA, Federal Highway Funds, General Fund
Priority	High
B-4	**Flood/Tsunami warning system**
Proposed Activities	Ensure early warning system for evacuation of areas at risk for flooding, tsunami inundation, seiches or dam failure
Hazard	Tsunami, Flood, Dam failure, Multi hazard
Environ Concerns	None
Lead Department	Emergency Operations/Fire/**OES**; Police; **Water**
Timeline	Under development [2018]
Resources Required	Staff time; coordination with county and other municipalities
Funding Source	~~City~~ General Fund
Priority	High

	High Priority Actions
B-5	**Regulate floodplain development**
Proposed Activities	Regulate development in floodplains and increase public awareness of flood hazards
Hazard	Floods
Environ Concerns	Flood inundation resulting in failed building and infrastructure, contamination, loss of businesses, homes and life.
Lead Department	Planning and Building
Timeline	**Ongoing**
Resources Required	Staff time; currently monitored between Planning and Building and Economic Development Departments
Funding Source	General Fund
Priority	High
B-6	**Federal Flood Insurance Program (FIP) participation**
Proposed Activities	Encourage property owners, potential buyers, and residents living in floodplains and coastal inundation areas to participate in the Federal Flood Insurance Program
Hazard	Flood and tsunami
Environ Concerns	Flood inundation resulting in failed building and infrastructure, contamination, loss of businesses, homes and life.
Lead Department	Planning and Building
Timeline	**Ongoing**; current regulations have been updated to bring local ordinances into compliance with federal regulations
Resources Required	Staff time
Funding Source	None
Priority	High
B-7	**Reduce creek flooding**
Proposed Activities	Reduce flooding hazard potential along creeks through implementation of Citywide Creeks and Wetlands Management Plan
Hazard	Flood
Environ Concerns	Land use issues
Lead Department	Planning and Building
Timeline	Ongoing
Resources Required	Staff time and funds
Funding Source	General Fund
Priority	High

	High Priority Actions
B-8	**Storm drain rehabilitation**
Proposed Activities	Rehabilitate the City's storm drain system to reduce local flooding caused by inadequate storm drainage
Hazard	Flood
Environ Concerns	None
Lead Department	Public Works
Timeline	**Ongoing**
Resources Required	$5–$10 million
Funding Source	Unidentified grant funds, General Fund, Storm Water Fund
Priority	High
B-9	**Promote early warning systems**
Proposed Activities	Promote installation, inspection and testing of built-in fire extinguishing and early warning fire alarm systems
Hazard	Wildfire
Environ Concerns	Addressed when building permit is issued
Lead Department	Fire/**OES**; Planning and Building
Timeline	**Ongoing**
Resources Required	Variable staff time
Funding Source	Permit fees
Priority	High
B-10	**Wildfire hazard abatement**
Proposed Activities	Abate hazardous conditions identified and create programs that are proactive not reactive
Hazard	Wildfire
Environ Concerns	Code compliance and public posting of fire danger
Lead Department	Fire
Timeline	**Ongoing**
Resources Required	Staff time and additional unidentified funding
Funding Source	Staff budget and grants
Priority	High

	High Priority Actions
B-11	**~~Minimize Risks from~~ Prevent dam failure**
Proposed Activities	Monitor **~~dams and infrastructure to preserve water resources and minimize risks to people and property resulting from dam failure.~~ Newell Creek Dam and infrastructure to preserve water resources and minimize risks to people and property resulting from dam failure; Replace or rehabilitate inlet/outlet works to meet Division of Safety of Dams operational requirements**
Hazard	Landslide, earthquake, liquefaction, multi-hazard
Environ Concerns	Flooding
Lead Department	Water, California Department of Water Resources and Division of Safety of Dams
Timeline	**Ongoing**
Resources Required	**~~.5 FTE plus outside consultants (geologists, geotechnical and civil engineers)~~ Capital Improvement Investment of $40 million; City staff plus outside consultants (geologists, geotechnical and civil engineers)**
Funding Source	Outside funding
Priority	High
B-12	**Flood control maintenance**
Proposed Activities	**Annual flood control maintenance on the San Lorenzo River as required by the Army Corps of Engineers consisting primarily of in-stream riparian vegetation management to prevent winter flows from exceeding capacity. Staff maintains the pump stations, gravity outlets and toe ditches as well.**
Hazard	**Flood**
Environ Concerns	**Habitat and Fish and Game**
Lead Department	**Public Works**
Timeline	**Annual (takes four to five weeks to complete)**
Resources Required	**Staff**
Funding Source	**Stormwater Fund**
Priority	**High**

	Important Actions
C-1	**Preserve and protect historic structures**
Proposed Activities	Encourage and support the protection of cultural, historic and architecturally significant structures to preserve neighborhood and community character
Hazard	Multi-hazard
Environ Concerns	Asbestos and lead paint
Lead Department	Planning and Building, Parks and Recreation
Timeline	3–5 years as funding is available ~~**(priorities are Holy Cross High School, UCSC lime kiln buildings and Pogonip Club house)**~~ **(priority structures have been addressed)**
Resources Required	$4–$6 million dollars
Funding Source	Unidentified state and federal grants and private funds
Priority	Important
C-2	**Update GIS data systems and mapping**
Proposed Activities	Update and enhance the GIS data systems and mapping for all hazards in the ~~c~~**C**ity
Hazard	Multi-hazard including climate induced hazards
Environ Concerns	None
Lead Department	Economic Development and **Information Technology**/GIS
Timeline	Unknown — based on funding availability
Resources Required	.5 FTE GIS and 1 FTE Project Manager
Funding Source	Outside funding not yet identified
Priority	Important
C-3	**Critical structure appraisal/estimates**
Proposed Activities	Obtain appraisals or~~/~~engineering estimates for City owned **Information Technology infrastructure** for critical **facilities** ~~**structures**~~
Hazard	Multi-hazard
Environ Concerns	None
Lead Department	Information Technology (**IT/**GIS) and Economic Development; **Planning and Building**
Timeline	City facilities study to be done
Resources Required	Outside consultants (appraisers and engineers)
Funding Source	Budgeted
Priority	Important
C-4	**Fire protection land use**
Proposed Activities	Discourage locating public facilities (other than open space uses) and above ground utilities in high fire hazard areas
Hazard	Wildfire
Environ Concerns	Addressed in Planning and Building process
Lead Department	Fire; Planning and Building
Timeline	**Ongoing**
Resources Required	Unknown staff time
Funding Source	Permit fees
Priority	Important

	Important Actions
C-5	**Adequate ~~S~~staffing**
Proposed Activities	~~**Ensure adequate firefighting and prevention staffing and that programs meet the needs of the City's populations and new construction near wildland interface areas**~~ **Identify potential funding mechanisms to obtain fuel reduction grants**
Hazard	Wildfire
Environ Concerns	None
Lead Department	Fire
Timeline	**Ongoing**
Resources Required	Additional staff
Funding Source	Unknown
Priority	Important
C-6	**Fire Safety Prevention Programs**
Proposed Activities	Continue fire safety prevention programs for schools, high occupancy uses and commercial and industrial facilities.
Hazard	Wildfire
Environ Concerns	None
Lead Department	Fire
Timeline	**Ongoing**
Resources Required	Regular staff time and additional funds required
Funding Source	Staff budget and grant funds
Priority	Important
C-7	~~**Global Warming Policies**~~ **Climate Change Policies**
Proposed Activities	Address ~~**global warming**~~ climate change in General Plan Update — implement policies and programs to reduce impacts of global warming
Hazard	Multi-hazard including drought, **wildfire,** coastal erosion and flooding
Environ Concerns	Reduce emissions that contribute to ~~**global warming**~~ climate change
Lead Department	**City Manager's Office,** Planning and Building
Timeline	General Plan Update adopted; Climate Adaptation **(update underway 2017)** and Climate Action Plans adopted; ongoing implementation
Resources Required	Staff time
Funding Source	**Permit fees, General Fund** ~~**as well as unidentified grants for special studies and implementation,**~~ **internal Carbon Reduction Fund as well as unidentified grants for special studies and implementation**
Priority	Important

	Important Actions
C-8	**Retrofit non-complying unreinforced masonry buildings (URM)**
Proposed Activities	Mandatory retrofit of identified structures; **[NOTE: Commercial URMs have been completed]**
Hazard	Earthquake
Environ Concerns	Asbestos and lead exposure-, building collapse in earthquake
Lead Department	Planning and Building
Timeline	~~**Five years for final URMs — Holy Cross High School (discovered 2006) all other known URMs have been retrofitted.**~~ **Two-story residential building currently in plan review**
Resources Required	Some staff time
Funding Source	Building fees
Priority	Important
C-9	**Upgrade structural safety**
Proposed Activities	Working with appropriate agencies, upgrade the structural safety of all existing emergency use and critical structures, such as medical facilities, schools, police, fire and emergency response centers as necessary and appropriate
Hazard	Multi-hazard
Environ Concerns	Building failure/collapse and response disruption
Lead Department	Planning and Building~~**; Public Works**~~
Timeline	Ongoing (public schools are state responsibility)
Resources Required	Unknown
Funding Source	General ~~f~~Fund and Capital Improvement Program
Priority	Important; Fire stations have recently been upgraded. **Corporation Yard Main building will be complete in 2018**
~~**C-10**~~	~~**Flood control maintenance**~~
~~**Proposed Activities**~~	~~**Annual flood control maintenance on the San Lorenzo River as required by the Army Corps of Engineers consisting primarily of in-stream riparian vegetation management to prevent winter flows from exceeding capacity**~~
~~**Hazard**~~	~~**Flood**~~
~~**Environ Concerns**~~	~~**Habitat and Fish and Game**~~
~~**Lead Department**~~	~~**Public Works**~~
~~**Timeline**~~	~~**Annual (takes four to five weeks to complete)**~~
~~**Resources Required**~~	~~**Staff**~~
~~**Funding Source**~~	~~**General Fund**~~
~~**Priority**~~	~~**Important**~~

PART 5 — PLAN MAINTENANCE PROCESS

- Monitoring, Evaluating and Updating the Plan
- Incorporation into Existing Planning Mechanisms
- Continued Public Involvement

CHAPTER 14: PLAN MAINTENANCE PROCESS

14.5.1 Monitoring, Evaluating and Updating the Plan

5.1 Identification and Analysis of Mitigation Actions — Requirement §201.6(c)(4)(i):

The plan maintenance process **shall** include a section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan within a five-year cycle.

Title 44 of the *Code of Federal Regulations* (CFR) Section 201.6(c)(4)(i) requires a hazard mitigation plan to include a plan maintenance process that includes the following:

- A section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan within a five-year cycle.
- A process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms, such as comprehensive or capital improvement plans, when appropriate.
- A discussion on how the community will continue public participation in the plan maintenance process.

The plan maintenance section of this document details the formal process that will ensure that the City of Santa Cruz hazard mitigation plan remains an active and relevant document. The maintenance process includes a schedule for monitoring and evaluating the plan annually each December in consultation with the Fire Department, Planning Department and Public Works Department. An updated plan will be produced every five years.

This chapter also describes how the City will integrate public participation throughout the plan maintenance and implementation process. Finally, this chapter explains how the City intends to incorporate the mitigation strategies outlined in this LHMP into existing planning mechanisms and programs, such as the General Plan, Capital Improvement Program, as well as building code enforcement and implementation. The LHMP's format allows the City to review and update sections when new data becomes available. New data can be easily incorporated, resulting in a plan that will remain current and relevant to the City of Santa Cruz.

Evaluation of the Plan

The minimum task of the ongoing annual hazard mitigation planning team meeting will be the evaluation of the progress of the LHMP and incorporating the actions into other plans.

This review will include the following:

- Summary of any hazard events that occurred during the prior year and their impact on the community.
- Review of successful mitigation initiatives identified in the LHMP (Appendix K: Successful Programs and Projects).

- Brief discussion about why targeted strategies were not completed.
- Re-evaluation of the action plan to determine if the timeline for identified projects needs to be amended (such as changing a long-term project to a short-term project because of funding availability: Chapter 13: Mitigation Strategy).
- Recommendations for new projects.
- Changes in, or potential for, new funding options (grant opportunities).
- Integration of new data such as GIS data and mapping used to inform the Plan.
- Impact of any other planning programs or initiatives within the City that involve hazard mitigation.

The planning team will create a template to guide the LHMP committee in preparing a progress report.

The planning team will prepare a formal annual report on the progress of the LHMP. This report will be used as follows:

- Distributed to Department Heads for review.
- Posted on the City website on the page dedicated to the LHMP.
- Provided to the local media through a press release.
- Presented in the form of a council report to the Santa Cruz City Council.
- Provided as part of the Community Rating System (CRS) annual re-certification package. The CRS program requires an annual recertification to be submitted every year. To meet this recertification timeline, the planning team will strive to complete this progress report prior to the CRS recertification.

Method and Schedule for Updating the Plan within 5 Years

Section 201.6.(d)(3) of Title 44 of the *Code of Federal Regulations* requires that local hazard mitigation plans be reviewed, revised if appropriate, and resubmitted for approval in order to remain eligible for benefits awarded under the Disaster Mitigation Act. The City of Santa Cruz intends to update the LHMP on a five-year cycle from the date of initial plan adoption. This cycle may be accelerated to less than five years based on the following triggers:

- A Presidential Disaster Declaration that impacts the City of Santa Cruz.
- A hazard event that causes loss of life.

It will not be the intent of this update process to start from "scratch" and develop a new complete hazard mitigation plan for the City of Santa Cruz. Based on needs identified by the planning team, this update will, at a minimum, include the elements below:

- The update process will be convened through a committee appointed by the City Manager or designee in conjunction with Public Works and Planning Departments and will consist of at least one staff member from each of departments identified as lead departments in the mitigation action plan. This will ensure consistency between the LHMP and other city plans such as the General Plan and CIP.

- The hazard risk assessment will be reviewed and updated using best available information and technologies on an annual basis.
- The evaluation of critical structures and mapping will be updated and improved as funding becomes available.
- The action plan will be reviewed and revised to account for any actions completed, dropped, or changed and to account for changes in the risk assessment or new City policies identified under other planning mechanisms, as appropriate (such as the General Plan).
- The draft update will be sent to appropriate agencies for comment.
- The public will be given an opportunity to comment prior to adoption.
- The Santa Cruz City Council will adopt the updated plan.

Implementation Through Existing Programs

The effectiveness of the City's non-regulatory LHMP depends on the implementation of the plan and incorporation of the outlined action items into existing City plans, policies, and programs. The LHMP includes a range of action items that, if implemented, would reduce loss from hazard events in the City of Santa Cruz. Together, the action items in the LHMP provide the framework for activities that the City can choose to implement over the next five years. The planning team has prioritized the plan's goals and identified actions that will be implemented (resources permitting) through existing plans, policies, and programs.

The Public Works and Planning Departments have taken on the responsibility for overseeing the plan's implementation and maintenance through the City's existing programs. The two departments will work to facilitate LHMP implementation and maintenance meetings. Although these two departments will have primary responsibility for review, coordination, and promotion of the plan; plan implementation and evaluation will be a shared responsibility among all departments identified as lead departments in the mitigation action plan. The Public Works Department will continue to work closely with the Fire Department/OES Analyst to insure consistency in plans.

14.5.2 Incorporation into Existing Planning Mechanisms

5.2 Identification and Analysis of Mitigation Actions — Requirement §201.6(c)(4)(ii): The plan **shall** include a process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms such as the comprehensive or capital improvement plans when appropriate.

A PLANNING MECHANISMS FOR INCORPORATING THE REQUIREMENTS OF THE PLAN

The information on hazard, risk, vulnerability, and mitigation contained in this plan is based on the best information and technology available at the time the LHMP was prepared. As previously stated, the City's General Plan is considered to be an integral part of this plan. The City, through adoption of its General Plan (specifically, the Safety Element) goals, has planned for the impact of natural hazards.

The LHMP process and subsequent Five Year Updates, provided the City with the opportunity to review and expand on policies contained within the General Plan. The City views the General Plan and the LHMP as complementary planning documents that work together to achieve the ultimate goal of the reduction of risk exposure to the citizens of Santa Cruz. Many of the ongoing recommendations identified in the mitigation strategy are programs recommended by the General Plan, Urban Water Management Plan, Capital Improvement Program and other adopted plans.

The City will coordinate the recommendations of the LHMP with other planning processes and programs including the following:

- Emergency Operations Plan
- Capital Improvement Program
- City of Santa Cruz Municipal Code
- Community design guidelines
- Water conservation guidelines
- Stormwater Management Program

The following describes how the items listed above will be incorporated into the LHMP and how these items may be modified by, or inform, the LHMP.

Emergency Operations Plan The Hazard Analysis appendices of the EOP will (when completed) directly reflect the findings and analyses in the LHMP.

Capital Improvement Program A major contributor to the LHMP was the City Engineer, Parks Director and Deputy Water Director, who manage most aspects of the Capital Improvement Plan; the Project Manager has recommended that annual consideration of the CIP during the City budget cycle include a review of the LHMP Action Items.

City of Santa Cruz Municipal Code provisions include Emergency Preparedness language (Chapter 2.20). Provisions in the Code include language incorporating mitigation and response/recovery actions. To quote relevant language in Section 2.20.020 (in part, with emphasis added): ""Emergency services" is the preparation for, and the execution of, all emergency functions, other than functions for which military forces are primarily responsible, to prevent, minimize, and repair injury and damage resulting from an emergency…" Additional areas of the Code reflect specific potential hazards such as water shortage. These are dealt with extensively in the LHMP. It is not anticipated that the LHMP findings and hazard analyses will cause additions to, or revisions of, the Santa Cruz Municipal Code which lays out broader functions rather than specific actions related to hazard mitigation.

Community design guidelines differ from other regulatory land use requirements in that design guidelines, from a land use planning perspective, are most often associated with aesthetics, whereas regulatory language is less subjective. The City does not have any specific design guidelines which would directly influence or diminish opportunities for climate adaptation, but there are some situations where design of an adaptation measure may influence adaptation. One hypothetical example would be a height limit if areas were required to elevate habitable space above a flood level. Improved coastal sea level rise mapping may lead to refinement of wave inundation areas near the beach, which could potentially lead to requiring elevated habitable floors near high hazard areas. Regulations in these areas would be required to be certified by the California Coastal Commission, which has in the past had direct concerns about heights in certain beach areas. Such a conflict would need to be identified and discussed if mitigation regulations were to be developed in these areas.

Another example of a state level design guideline that directly relates to Climate Adaptation/Mitigation is that of coastal armoring. The aesthetic preference typically desired for Coastal Commission permits is to mimic natural bluffs for revetments and coastal armoring, where suitable. Historically, rip-rap is easier to maintain, is less expensive, and response time can be greatly reduced in the event of a natural disaster of other emergency. This higher level of aesthetic design quality is recognized as desirable as an aesthetic public value, but such high standard for design directly leads to an increase of design and review time, as well as an increase of public costs to implement climate adaptation and/or mitigation measures in urban areas.

Water conservation guidelines are an integral piece of the LHMP and the subject is dealt with extensively. There is a direct relationship (see Drought, Chapter 7) between mitigation planning and the actions described in various, mandated, water conservation and emergency plans.

Stormwater Management Program best practices guidelines for industry, home repair, commercial and public development projects as well as pollution prevention guidelines, all contribute to helping mitigate potential hazards, though many are not considered natural hazards (such as those in this LHMP). However, since adherence to stormwater best practices, can help prevent hazards such as extreme runoff, contamination of water supplies and similar environmental issues, they contribute to overall mitigation activities which is the goal of the LHMP.

Most action items do not need to be implemented through regulation. Instead, these items can be implemented through the creation of educational programs, continued interdepartmental and interagency coordination, or improved public participation.

14.5.3 CONTINUED PUBLIC INVOLVEMENT

5.3 Continued Public Involvement —
Requirement §201.6(c)(4)(iii):

The plan maintenance process **shall** include a discussion on how the community will continue public participation in the plan maintenance process.

The public will continue to be apprised of LHMP actions through the City website. Copies of the LHMP will be distributed to the Santa Cruz Library System. Upon initiation of the LHMP update process, a new public involvement strategy will be initiated based on guidance from the committee. This strategy will be based on the needs and capabilities of the City at the time of the update. At a minimum, this strategy will include the use of local media outlets within the planning area and the City's website.

Throughout the maintenance phase of the Local Hazard Mitigation Plan, whenever the Plan is to be revised, changed or updated (per FEMA requirements), the public — as in past Plan development phases — will be able to comment and provide input. For example, the City will continue to produce a public survey and newspaper "call for comments" at the outset of a major update to the Plan. E-mails will be sent to established community and other neighborhood groups as well. Interactive mechanisms (survey and website query option; and public meetings) will be established as methods for the public to comment on the plan.

Additionally, as the Climate Adaptation Plan (Appendix P) is a key part of the LHMP, there is now in place an extensive effort to expand upon public events and outreach efforts. The Climate Action Program has launched its "Climate Adaptation Outreach" campaign with over 20 events scheduled (in 2018) including specific activities meant to engage, prepare and gain feedback from the community.

For this LHMP Update, as described in the following Chapter 15: Public Outreach and Plan Development, public comments were also gathered through:

- A community-wide survey which is included along with tabulated responses and analysis, below;
- Through public presentations at multiple City Advisory Body meetings (Transportation and Public Works Commission [twice], Planning Commission and Downtown Commission); and,
- Through presentations to the City Council

CHAPTER 15: PUBLIC OUTREACH AND PLAN DEVELOPMENT

This chapter outlines the steps that were taken to update the City of Santa Cruz 2018–2023 Local Hazard Mitigation Plan and to describe how it was distributed for review and comment to our community stakeholders, emergency management personnel and partners. Comments, where appropriate, were incorporated into the body of the LHMP to correct errors, add relevant and important updated information.

STAKEHOLDERS

County of Santa Cruz: Emergency Management Council

The members of County of Santa Cruz Emergency Management Council EMC) were invited to review the LHMP update at their regular meeting on May 4, 2017. The EMC is staffed by our County Office of Emergency Services Administrator and meets every other month. The membership consists of over forty (40) emergency management partners including representatives from all of the incorporated cities in the county, from the American Red Cross, Fire, Law Enforcement, the business community, our hospitals, ham radio (ARES) operations personnel, schools and the University of California Santa Cruz, public information officers, Public Health, faith based representatives, and others. The EMC Chair also sits as the Chair of the Citizen Corps Council. EMC meetings are also attended by CERT representatives, the County of Santa Cruz Medical Reserve Corps, Volunteer (VOAD) agencies and Santa Cruz County Equine Evacuation Unit. More information on the EMC role can be found at this website: Santa Cruz County EMC.

2012–2017 LHMP Review by Emergency Management Council

The LHMP was distributed via memo and email links to the EMC members and that body was given over thirty (30) days to review, comment and reply. Other than a thorough review by County OES, comments received were few and minor in nature. For example, it was suggested that the City of Santa Cruz move forward with a Tsunami Ready plan. We have started that effort, as noted in the Tsunami chapter (Chapter 8). Other comments were congratulatory in nature but not substantive.

2018–2023 LHMP Review by Emergency Management Council

The LHMP was discussed at the EMC May 4, 2017 regular meeting. The project was outlined to the membership and a request was made for jurisdictional and agency stakeholder/members to review and comment back to the Project Manager. A DRAFT copy of the LHMP (approximately 90% complete) was later made available to the peer review members. It was distributed as a PDF email file attachment.

The following neighboring jurisdictions, agencies and special district representatives were included in the City of Santa Cruz invitation and request for review of the 2018–2023 LHMP.

List is current as provided by the County Office of Emergency Services March 2017.

(NOTE: Updated via web search November 20, 2011 for accuracy related to members' agency affiliations.)

EMC Member	Representing
Anthony Loero	Santa Cruz County: Building Mntc. Supt.
Argelia Soria	Santa Cruz County Health Services
Bob Wiser	ARES (amateur radio)
Brenda Brenner	EMS Administrator
Brenda Gonzalez	United Way
Brian Sherin (Chair)	County Appointee: At-Large Representative
Camilla Boolootian	American Red Cross
Cap Pennell	ARES (amateur radio)
Carl Johnson	City of Watsonville: Public Works
Carlos Palacios	SC County Administrative Officer
Carol Johnson	SC County Administrative Assistant
Catrina Christian	Cal OES: Regional Operations
[new appointee 2017]	Aptos Fire
Chris Jones	American Medical Response: Operations Mgr.
Christina Cuevas	Community Foundation Santa Cruz County
Christine Mead	Soquel Creek Water District
Ciro Aguirre	Santa Cruz Metropolitan Transit District
Colt Esenwein	Santa Cruz County: Public Works
Cori Burt	Community Bridges (non-profit)
Craig Jenni	American Red Cross
David Brown	SC County Admin.: Office: Senior Analyst
David McNair	Scotts Valley Water District: Operations Mgr.
Dawne Harman	SC County: Assistant Public Works Supt.
Deborah Smith	SC County OES: Administration
Debra Means	SC County Admin./Clerk Ofc: Asst. & Secretary
[new appointee]	SC Regional 911
Diane Bridgeman	Licensed Clinical Psychologist
Donna Stidolph	County Equine Evacuation
Dr. Marcus Kwan	Medical Reserve Corps
Duf Fischer	Santa Cruz Chamber of Commerce
Giang Nguyen	SC County Health Services Agency: Director
Dr. Heather Thomsen	First 5 Santa Cruz
Ian Larkin	Cal Fire: Deputy Chief
Jason Hoppin	SC County: Communications Manager
Jeanette Cosentino	Dignity Health Dominican Hospital
Jeremy Verinsky	SC County Sheriff: Undersheriff
Jerry Inman	ARES (amateur radio)
Jim Howes	SC County ROP: Assistant. Director
Jim Uhey	Cal VOAD (volunteer organizations): President

EMC Member	Representing
Joe Christy	Bonny Doon Fire Safe Council: President
Joe Foster	PG&E: Government Relations/Public Affairs
Joe Nugent	Cabrillo College: Dir. Facilities and Plant Ops
John Presleigh	SC County: Director of Public Works
JohnWilson	Scotts Valley: Police Chief
Karen Delaney	SC County Volunteer Center: Executive Dir.
Kevin Bowling	SC County Information Services: Director
Kevin Bratcher	SC County GSA: Purchasing Manager
Kevin Cole	Soquel Creek Water Dist.: Field Supervisor
Kevin Fitzgerald	SC County: HSA Facilities Manager
Liz Taylor-Selling	SC County [Felton] CERT Leader
Lyn Hood	Equine Evacuation &Assistance Unit: Advisor
Lyn Robinson	Valley Churches United Missions: Exec. Dir.
Marcela Tavantzis	SC County: Asst. Director. of Public Works.
Marian Olin	SC Port District: Port Director
Mark Carbonaro	KION Radio: Public Service Director
Martin Heaney	SC County: Building Official
Mary Sullivan-White	Equine Evacuation &Assistance Unit: Logistics
Matko Vranjes	SC County: HSA Mental Health Client Specialist
Matt Price	SC County: GIS Manager
[Medical Resp, Corp.[	SC County Medical Reserve Corps
Melanie Sobel	SC County: Animal Shelter General Manager
Melody MacDonald	SC Regional 911: Operations Supervisor
Michael Beaton	SC County: Director of Administrative Services
Michael Bennett	SC County: Public Works
Mike Del Fava	SC County: Communications Division Manager
Nick Lucchesi	SC County: Dist. Attorney Administrative Aide
Pablo Barreto	Watsonville Fire Chief
Pamela Iriguchi	SC County: County Counsel Sr. Legal Secretary
Patrick Gibney	Dominican Hosp.: Emergency Mgmt./Hazmat
Patrick Goff	UCSC: Dir. Environmental Health & Safety
Patsy H. Gasca	American Red Cross: Disaster Program Mgr.
Paul Binding	SC County: Ag Comm. Vector Control Mgr.
Paul Horvat	City of SCruz: OES/Principal Admin. Analyst
Peter Detlefs	SC County: Economic Development
Piret Harmon	Scotts Valley Water District General Manager
Rachel Berlin	SC County: Volunteer Center
Randy Fedak	SC County: Chief Welfare Fraud Investigator
Rayne Marr	SC County: Homeless Services Coordinator
Rayvon Williams	Watsonville Airport Manager
Rob Sherman	Cal Fire: Assistant Chief
Robert Ritchey	ARES: District Emergency Coordinator
Romina Cervantes	Amer. Red Cross: Volunteer & Youth Svcs Mgr.
Rosemary Anderson	SC County: Emergency Services Manager

EMC Member	Representing
Scott Cullen	Aptos LaSelva Fire: Captain
Sharen Smithcamp	SC County: Health Svcs. Admin. Svcs. Director
Stephanie Zube	SC Regional 911: Operations Division Manager
Steve Hernandez	Watsonville: Water Dept. OPS Supervisor
Steve Wiesner	SC County: Public Works Asst. Dir, Road Mntc.
Taj Dufour	Soquel Creek Water Dist.: Chief Engineer/Mgr.
Tammy Spath	SC Regional 911: Administrative Supervisor
Tara Ireland	SC County: Volunteer Initiative Prgm. Coord.
Terri Cobbs	SC County: Senior Personnel Analyst
Toby Goddard	City of Santa Cruz: Water Conservation Mgr.
Todd Skrabak	Aptos La Selva Fire: Chief
Tom Held	City of Capitola: Police Department Captain
Will Forest	SC County Health Services: Epidemiologist

County of Santa Cruz Office of Emergency Services

The County of Santa Cruz Emergency Services Manager provided a high level review of this LHMP Update and her valuable comments and suggestions have been incorporated throughout this document.

Santa Cruz Neighbors: Community

The following is from the Santa Cruz Neighbors (SCN) website (Santa Cruz Neighbors):

> "Santa Cruz Neighbors is a city-wide 501(c)3 nonprofit organization representing a network of neighborhoods which partners with educational institutions, local government, local businesses, and non-profits dedicated to safer neighborhoods, community oriented government and provides a neighborhood voice for the residents of Santa Cruz."

A Citizen Survey concerning natural hazards awareness, issues and preparedness was sent out to members of the SCN by email link to their membership list. The same survey was posted on our City of Santa Cruz website for approximately two months. The email to SCN members encouraged them to reply to the survey. The survey results, including comments from our residents, are included later in this chapter.

City Departments: Project Team

A number of key individuals formed a Project Team that worked on the LHMP update. The work of this team was coordinated by the city's Management Professional and Technical Analyst working in conjunction with the city's Principal Management Analyst in charge of the City's OES Division within the Fire Department and with the City's Sustainability and Climate Action Coordinator. Other members worked independently — as subject matter experts — reviewing and updating their particular sections of the LHMP. They provided new, updated and revised information and data, all of which have been incorporated into the current update.

The LHMP Project Team included members from the Fire Department, Economic Development, Planning, Water, and Public Works departments. We also relied on, and greatly appreciate, the services of our Information Technology Systems Coordinator/GIS technician for updated mapping and HAZUS data, both of which contribute to the City's analysis and planning for long term mitigation strategy.

Many members of the team were familiar with the original plan from their work in 2012. Their contributions were invaluable in the formulation of the current plan. The work products and revisions were managed by the Management Professional and Technical Analyst who functioned as the Project Team Leader.

Continuity and Connections Among Plans

The author of the original City of Santa Cruz 2007 LHMP retired from city service. However, the bulk of the original plan was carried forward into the 2007–2012 update. The former Project Manager for the initial Five Year Update (2012–2017) had also retired, and was brought back in the position of Management Professional and Technical Analyst to manage this current 2018–2023 update. This adds a layer of continuity that was invaluable in getting the Project Team and the LHMP effort off to a quick and efficient start.

The current Project Team includes City staff who had contributed significantly to the 2007 and 2012 plans. It is worthwhile to note that our adopted Climate Adaptation Plan, which is cited throughout the LHMP and informs many aspects of the LHMP, was authored by the same person who wrote our 2007 LHMP. We continue to be grateful for the author's expertise which carries through from the original LHMP to the first update and to this update, as well as for her authorship of the Climate Adaptation Plan.

Climate Adaptation: The "Original" LHMP Update and Public Outreach/Review

The City of Santa Cruz broke new ground in our region and in the state when we completed and adopted a Climate Adaptation Plan. The work was accomplished through a Pre-Disaster Mitigation Grant. The final plan fulfilled the grant and was adopted by our City Council in 2011.

Our original intent was to have the Climate Adaptation Plan serve as our initial Five Year LHMP Update. Therefore, the Climate Adaptation Plan was written with a focus on the LHMP even while its subject matter was concentrated on climate change impacts. These impacts were prioritized so that the City would have a "roadmap" to mitigate potential problems in the future. In essence, the Climate Adaptation Plan is a companion mitigation document that expands upon the focus of the LHMP.

Extensive public reviews, public meetings, stakeholder meetings and outreach were undertaken in the process of preparing and adopting the Climate Adaptation Plan (*see* Appendix P).

As a result of CalOES' review of the Climate Adaptation Plan it was determined that it fell short as a formal LHMP update in that it did not address certain known vulnerabilities such as earthquakes and tsunamis. These were not considered by the authors as climate-related impacts and were thus not included in the Climate Adaptation Plan. CalOES' review was completed when the issues mentioned above were addressed, incorporating those non-climate change impacts, related vulnerabilities and their known risks to our community. This LHMP Update (2018–2023) — as did our first Five Year Update — includes the entire Climate Adaptation Plan Update and all of its valuable insights and direction.

OUTREACH MATERIALS

Following is a listing of materials used to gather insight, comment and in-depth peer and stakeholder review of the LHMP. This listing is not inclusive of all the email and phone conversations that went into this public outreach effort during plan development. However, they represent outreach to key stakeholders, residents in general and citizen groups.

- Email to city communications personnel and select Department Heads requesting Citizen Survey: "Are You Ready?" be posted on city websites and social media sites. (March 21, 2017)
- Media announcement of, and web link to, Citizen Survey: "Are You Ready?" sent to city communications personnel with request to post to media contacts. (March 21, 2017)
- In-house review (and comments back to Project Manager) re: Citizen Survey: "Are You Ready? Local Hazard Mitigation Public Survey" (March 21, 2017)
- Email to City Department Heads and web content managers; including links to Citizen Survey and LHMP requesting Facebook and web postings (March 22, 2017)
- Citizen Survey posted to city website home page and social media (March 22–24, 2017)
- Email to Santa Cruz Neighbors requesting they share the Citizen Survey with their members throughout the city. (March 22, 2017)
- Local newspaper publicizes the Citizen Survey (Santa Cruz Sentinel, March 29, 2017)
- Email to Chair of the County of Santa Cruz Emergency Management Council requesting peer reviewer suggestions from EMC membership (April 6, 2017)
- Meeting with Emergency Management Council personnel to solicit peer and stakeholder review and comment on DRAFT LHMP (May 4, 2017)
- City of Santa Cruz "City Hall to YOU" event included LHMP request for public comment (*see* flyer below) (May 4, 2017)
- Presentation to the Transportation and Public Works Commission Advisory Body (May 15, 2017)
- Citizen Survey and responses (provided below).
- Climate Adaptation Plan (LHMP Appendix P) presentation to the Transportation and Public Works Commission (July 17, 2017)

Santa Cruz Sentinel (local daily newspaper) "Coast Lines" printing
Announcing Citizen Survey and requesting local input and comments
March 29, 2017

SANTA CRUZ

3/29/2017

City issues hazard plan survey

The city of Santa Cruz is soliciting input with a Local Hazard Mitigation Public Survey from those who live and/or work within the city.

Feedback will be used to update the city's Local Hazard Mitigation Plan, which identifies risks from natural disasters. The city is also updating its Climate Adaptation Plan which identifies additional risk from climate related impacts.

Responses to the survey help evaluate major concerns and how well the community is prepared for the next natural disaster. It will also help determine how to mitigate the effects of natural disasters before they happen.

When the plan is adopted by the state and FEMA, the city can compete for grant funding to help prevent damage and reduce risks and vulnerabilities in neighborhoods throughout the city.

Survey: surveymonkey.com/r/LHMP_SURVEY.

Request for Public Input at "City Hall to YOU" event (City Hall to You)
May 4, 2017

City Hall to YOU
May 4, 2017

2017 CLIMATE ADAPTATION PLAN + LOCAL HAZARD MITIGATION PLAN UPDATE

CITY OF SANTA CRUZ
Climate Action Program

Provide your input NOW at our survey | Updates to be complete September, 2017

Sea Level Rise Vulnerability Assessment

- Central Coast Wetlands Group performing **GIS analysis**
- **New modeling and data** allows quantification of impacts (new to Plan)
- **Impacts assessed**: rising tides, coastal storm flooding + erosion
- **Scenarios analyzed** include
  - Existing conditions (2010 water level)
  - Low sea level rise (IPCC S1, where 41 cm rise by 2100)
  - Medium sea level rise (IPCC S2, where 88 cm rise by 2100)
  - High sea level rise (IPCC SS3, where 159 cm rise by 2100)
- **Time horizons analyzed** are 2010, 2030, 2060 and 2100
- **Outputs** include SLR impact maps at each time horizon, inventory and valuation of impacted facilities + infrastructure integrated into report narrative

Social Vulnerability Assessment

- **Technical Assistance** provided by Dr. Juliano Calil
- **New measure** to improve customization of adaptation strategies and actions
- **Social Vulnerability Score** includes
  - Poverty
  - Age > 65 years old
  - Crime incidence
  - English not spoken well or at all
- High Social Vulnerability Scores overlaid onto SLR and other impact maps

Climate Adaptation Plan Update

- Develop and prioritize adaptation strategies based on impacts and social vulnerability
- Update all narrative sections in report
- Update non coastal impacts with existing studies and new data available
- Stakeholder and technical advisor review and comment

What's Next

- Public Comment period ends on May 8, 2017 (see links to surveys)
- Integration with the Local Hazard Mitigation Plan over summer and crosswalk with other plans as needed
- Presentation to Planning Commission + Transportation and Public Works Commission in July
- Presentation to City Council in August
- Secure funding for Cost Benefit Analysis of business as usual vs. adaptation strategies, more public outreach and quantification of non-coastal impacts (e.g. urban wildfire potential and drought)
- Report on progress on Adaptation Plan update annually

For more information: contact Dr. Tiffany Wise-West
Twise-west@cityofsantacruz.com | 831.420.5433

Citizen Survey: Are you Ready? Local Hazard Mitigation Survey

On the following pages are the results of the Citizen Survey — "Are You Ready? Local Hazard Mitigation Public Survey." The survey was posted and distributed via internet links, social media and through the local community group in the City of Santa Cruz (Santa Cruz Neighbors). The survey was available for approximately two months. 386 responses were received which is three times as many as the 2012–2017 LHMP public survey.

The following image shows the introduction to our survey:

"Are You Ready? Local Hazard Mitigation Public Survey"

Are You Ready? Local Hazard Mitigation Public Survey

1. **Local Hazard Mitigation Plan Update 2017-2022: Public Survey**

This Survey is intended for those who live and/or work in the City of Santa Cruz.

Responding to this Survey will help city emergency managers as we update our Local Hazard Mitigation Plan. In fact, incorporating public input and comments is a required element for the plan to be adopted by FEMA and allow the City to seek emergency mitigation funds. This plan (LHMP) identifies risks from natural disasters and sets priorities for mitigation actions to help protect life, property and our environment.

Your responses to this Survey will help us evaluate what most concerns you about those natural disasters that may impact our City and your neighborhood in particular. It also asks how well you are prepared for the next natural disaster. The Survey will help city emergency planners determine how best to mitigate the effects of natural disasters before they happen.

Please help us work toward a safer and more resilient community by responding to this Survey. Your comments are welcomed and encouraged.

Current emergency management plans can be found at the following websites:
LHMP: Local Hazard Mitigation Plan 2012-2017
Climate Adaptation Plan: See Appendix P

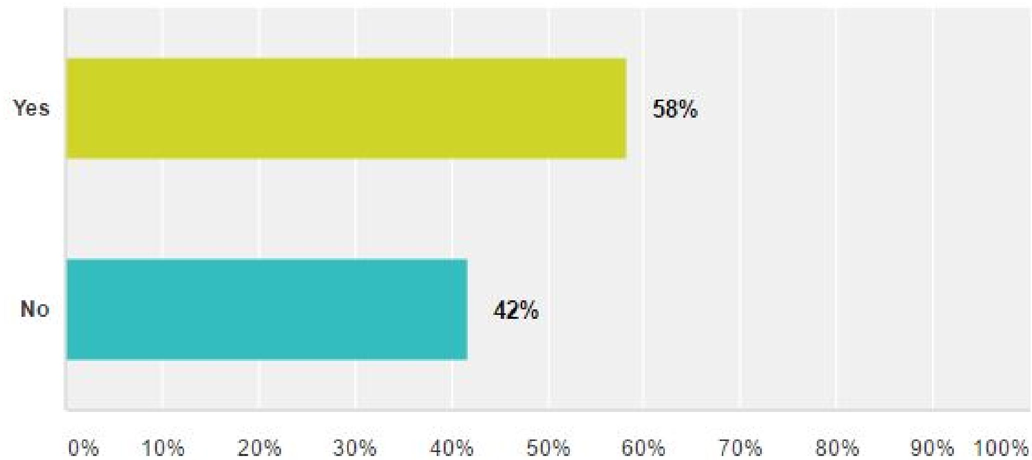
Please begin the Survey.... and thank you for participating.

NOTE: The following pages are screenshots taken from the final survey results. A closer look at these results follows the questions on the pages below.

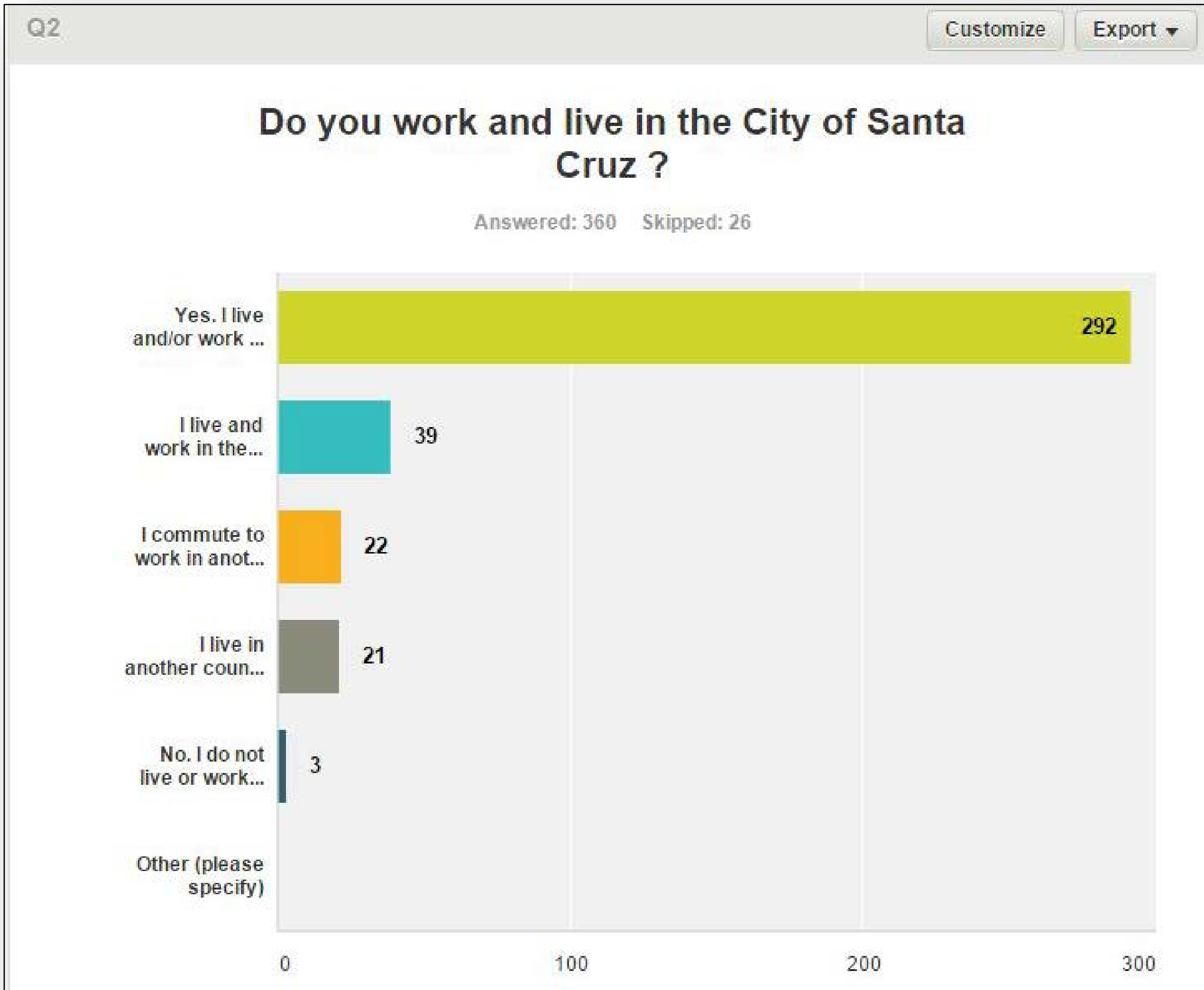
Q1 Customize Export ▾

Do you own property in the City of Santa Cruz?

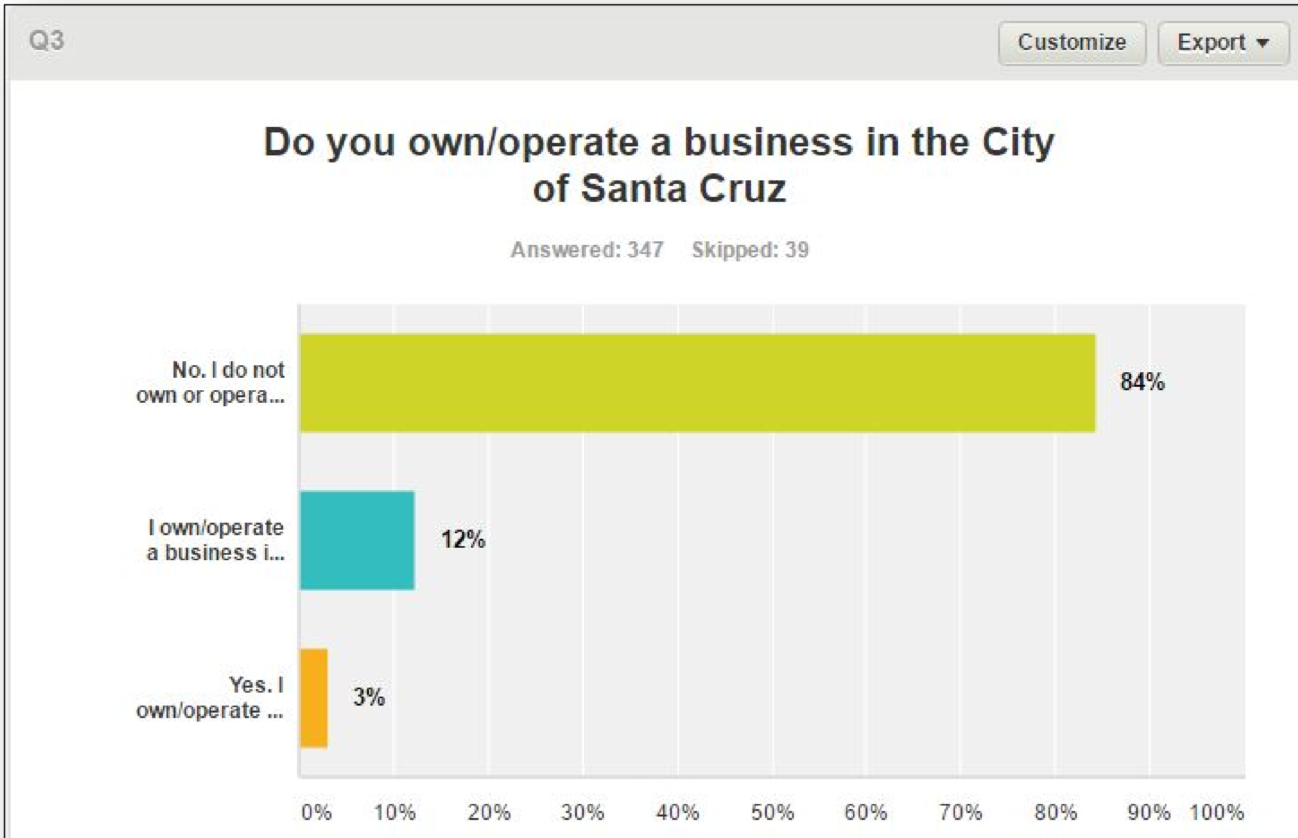
Answered: 384 Skipped: 2



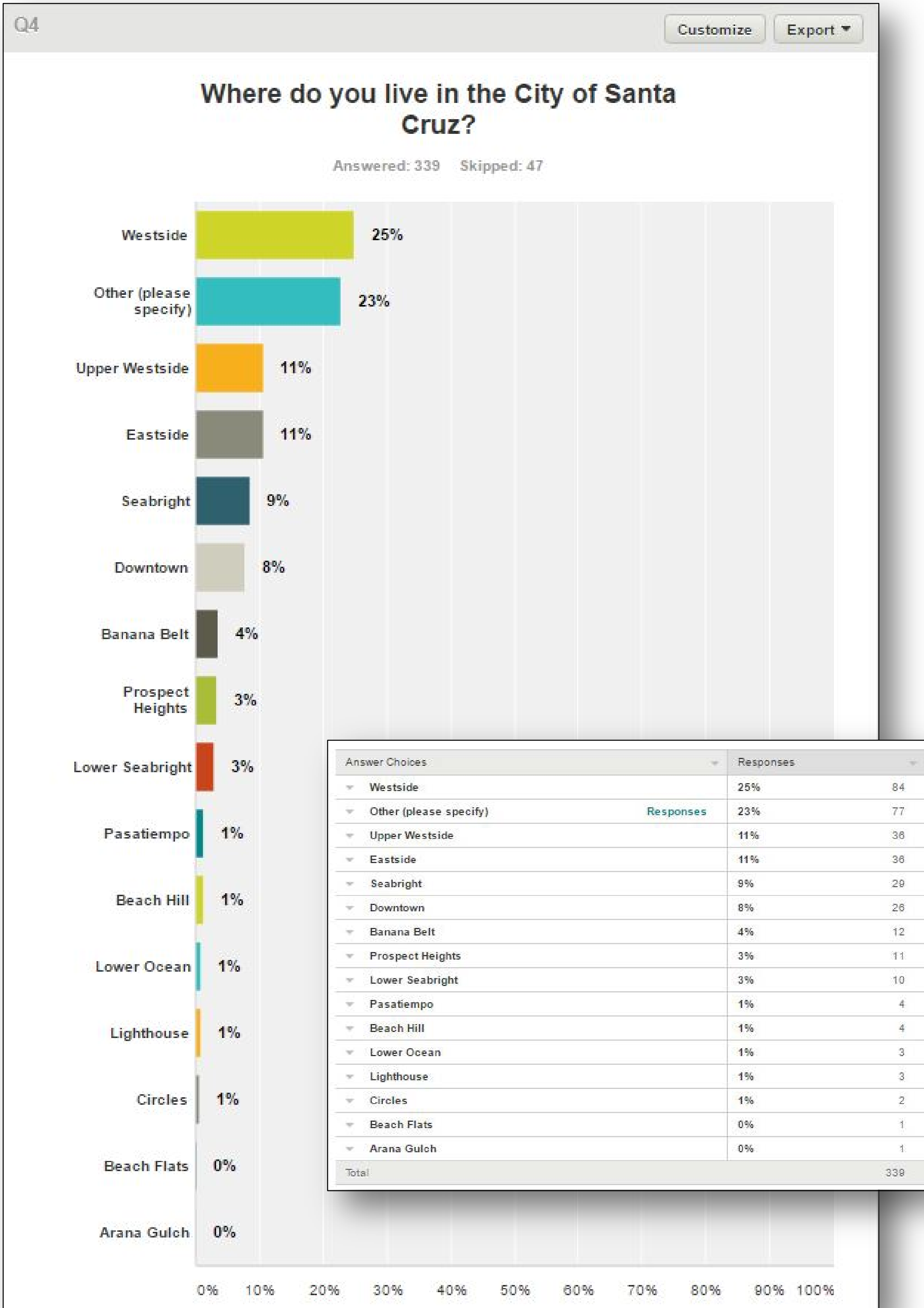
Answer Choices	Responses	
Yes	58%	224
No	42%	160
Total		384



Answer Choices	Responses	
Yes. I live and/or work in the City of Santa Cruz	81%	292
I live and work in the unincorporated area of the County of Santa Cruz (Live Oak, Aptos, etc.)	11%	39
I commute to work in another county from the City of Santa Cruz.	6%	22
I live in another county and commute to the City of Santa Cruz for work.	6%	21
No. I do not live or work in the City or County of Santa Cruz	1%	3
Other (please specify) Responses	0%	0
Total Respondents: 360		



Answer Choices	Responses	
No. I do not own or operate a business within the City of Santa Cruz	84%	293
I own/operate a business in the City, and I do live here	12%	43
Yes. I own/operate a business in the City, but do not live here	3%	11
Total		347

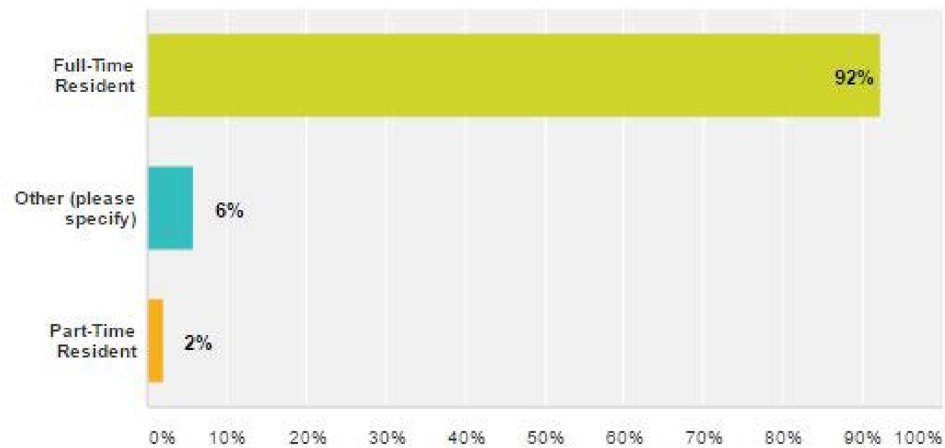


Answer Choices		Responses	
Westside		25%	84
Other (please specify)	Responses	23%	77
Upper Westside		11%	36
Eastside		11%	36
Seabright		9%	29
Downtown		8%	26
Banana Belt		4%	12
Prospect Heights		3%	11
Lower Seabright		3%	10
Pasatiempo		1%	4
Beach Hill		1%	4
Lower Ocean		1%	3
Lighthouse		1%	3
Circles		1%	2
Beach Flats		0%	1
Arana Gulch		0%	1
Total			339

Q5

Are you a full-time or part-time resident? If part-time please explain below.

Answered: 348 Skipped: 38

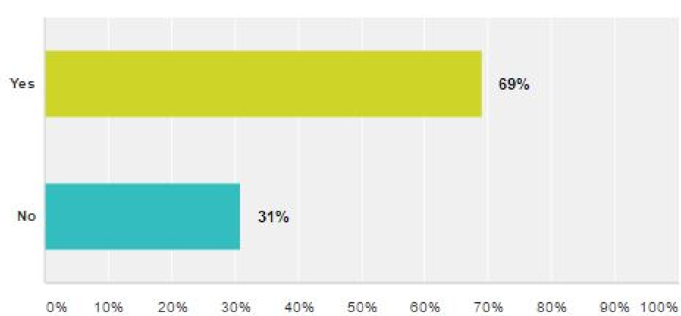


Answer Choices		Responses	
Full-Time Resident		92%	321
Other (please specify)	Responses	6%	20
Part-Time Resident		2%	7
Total			348

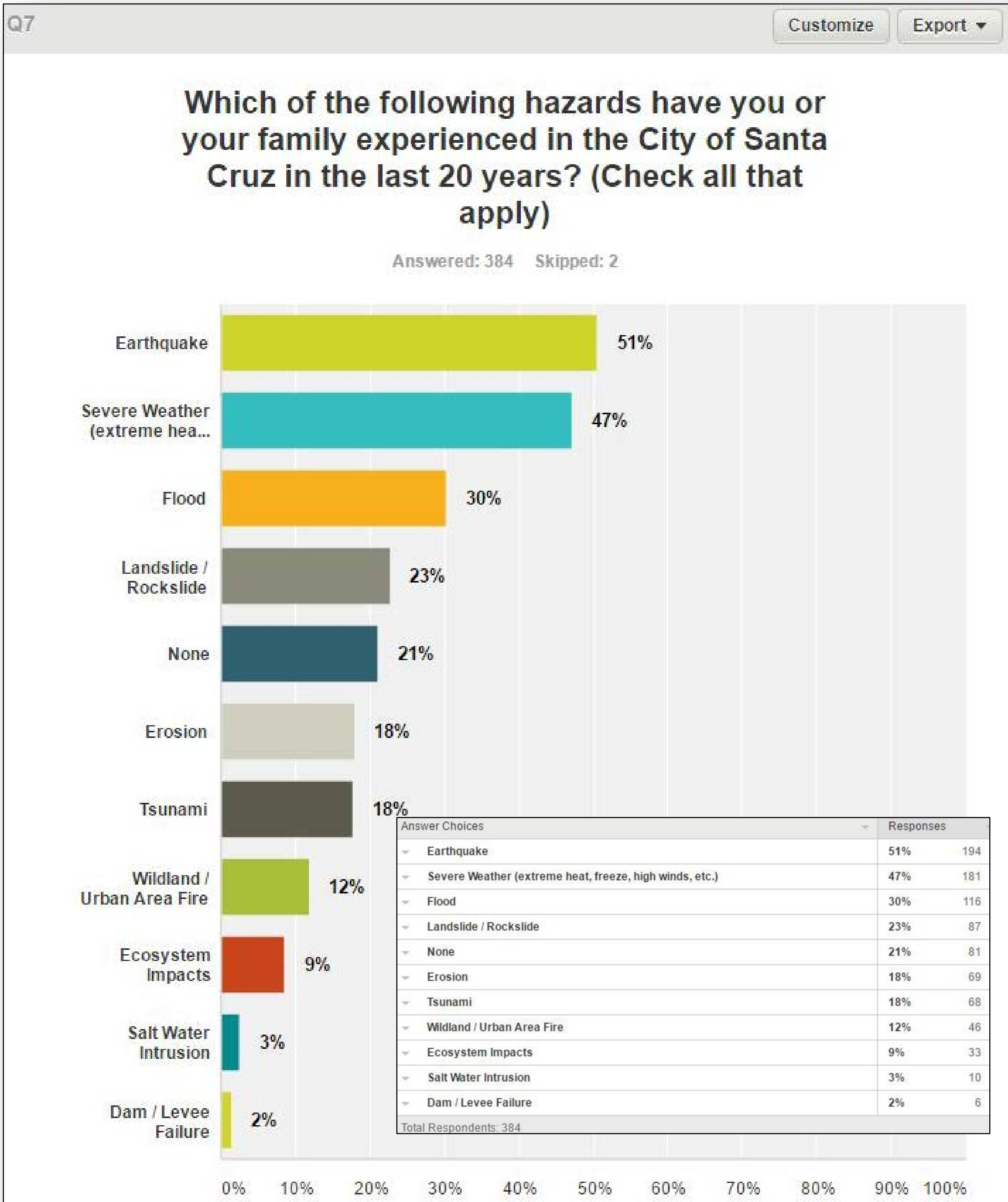
Q6

Do you work in the City of Santa Cruz?

Answered: 379 Skipped: 7



Answer Choices	Responses	
Yes	69%	262
No	31%	117
Total		379

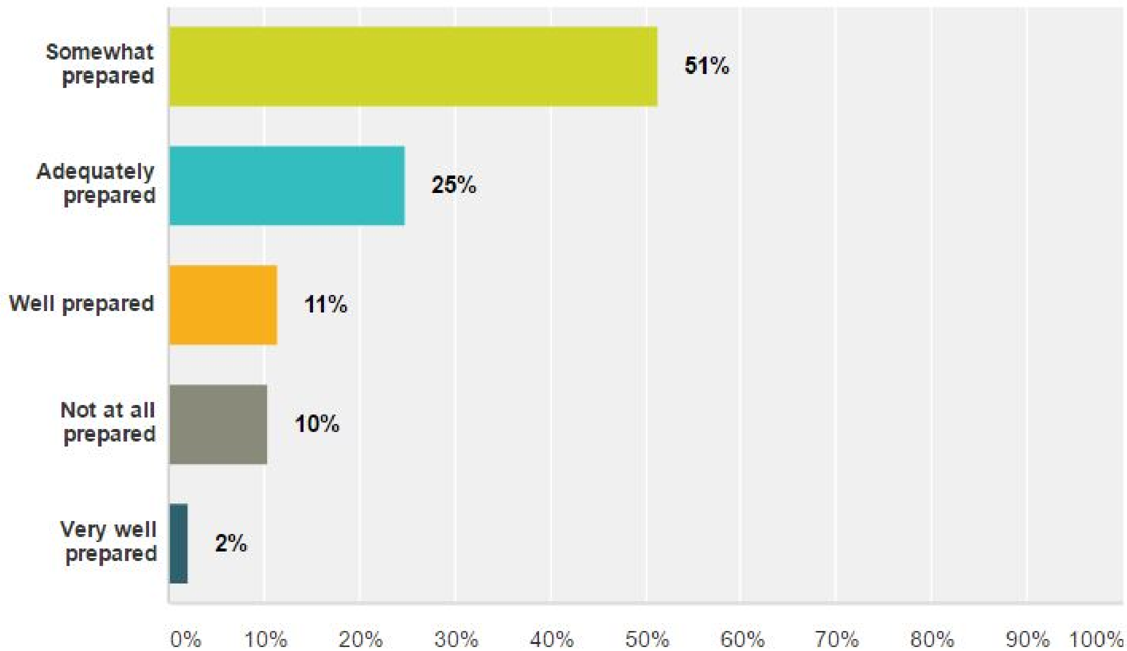


Answer Choices	Responses	
Earthquake	51%	194
Severe Weather (extreme heat, freeze, high winds, etc.)	47%	181
Flood	30%	116
Landslide / Rockslide	23%	87
None	21%	81
Erosion	18%	69
Tsunami	18%	68
Wildland / Urban Area Fire	12%	46
Ecosystem Impacts	9%	33
Salt Water Intrusion	3%	10
Dam / Levee Failure	2%	6
Total Respondents: 384		

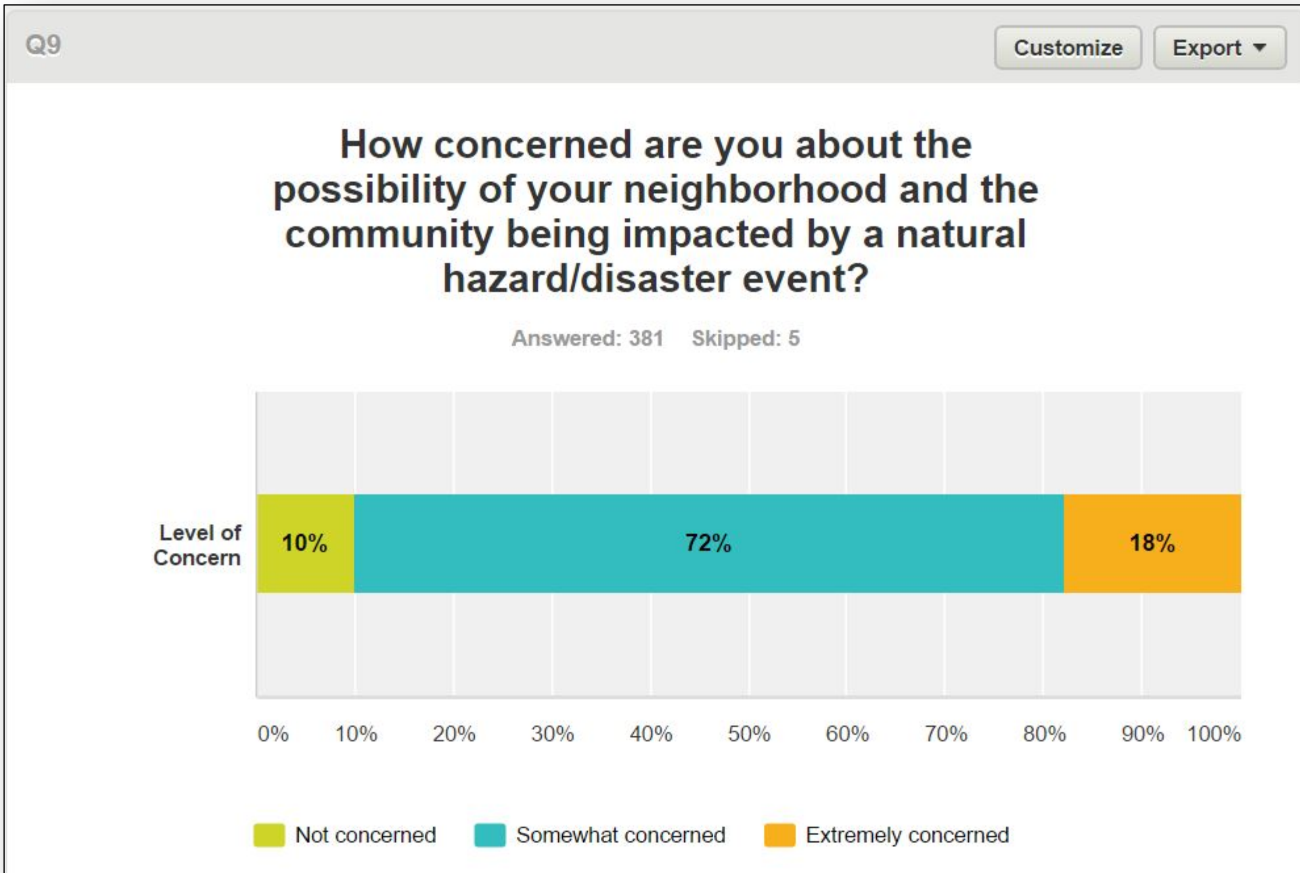
Q8 Customize Export

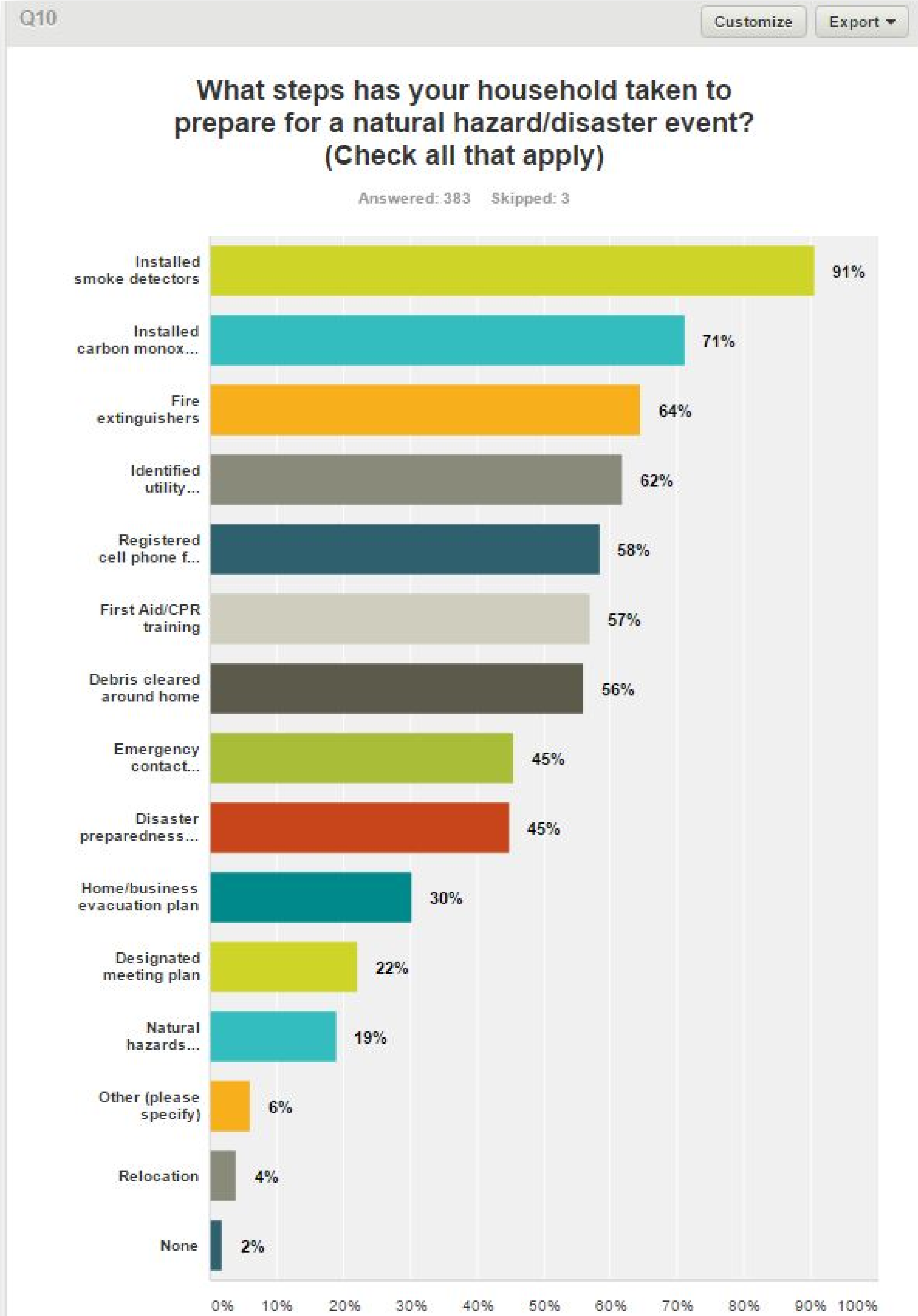
How prepared is your household for a natural hazard/disaster event?

Answered: 384 Skipped: 2



Answer Choices	Responses	
Somewhat prepared	51%	197
Adequately prepared	25%	95
Well prepared	11%	44
Not at all prepared	10%	40
Very well prepared	2%	8
Total		384


Q9
Customize
Export
How concerned are you about the possibility of your neighborhood and the community being impacted by a natural hazard/disaster event?
Answered: 381 Skipped: 5
Level of Concern
10%
72%
18%
0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Not concerned
Somewhat concerned
Extremely concerned


Q10
Customize
Export
What steps has your household taken to prepare for a natural hazard/disaster event? (Check all that apply)
Answered: 383 Skipped: 3
Installed smoke detectors 91%
Installed carbon monox... 71%
Fire extinguishers 64%
Identified utility... 62%
Registered cell phone f... 58%
First Aid/CPR training 57%
Debris cleared around home 56%
Emergency contact... 45%
Disaster preparedness... 45%
Home/business evacuation plan 30%
Designated meeting plan 22%
Natural hazards... 19%
Other (please specify) 6%
Relocation 4%
None 2%
0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

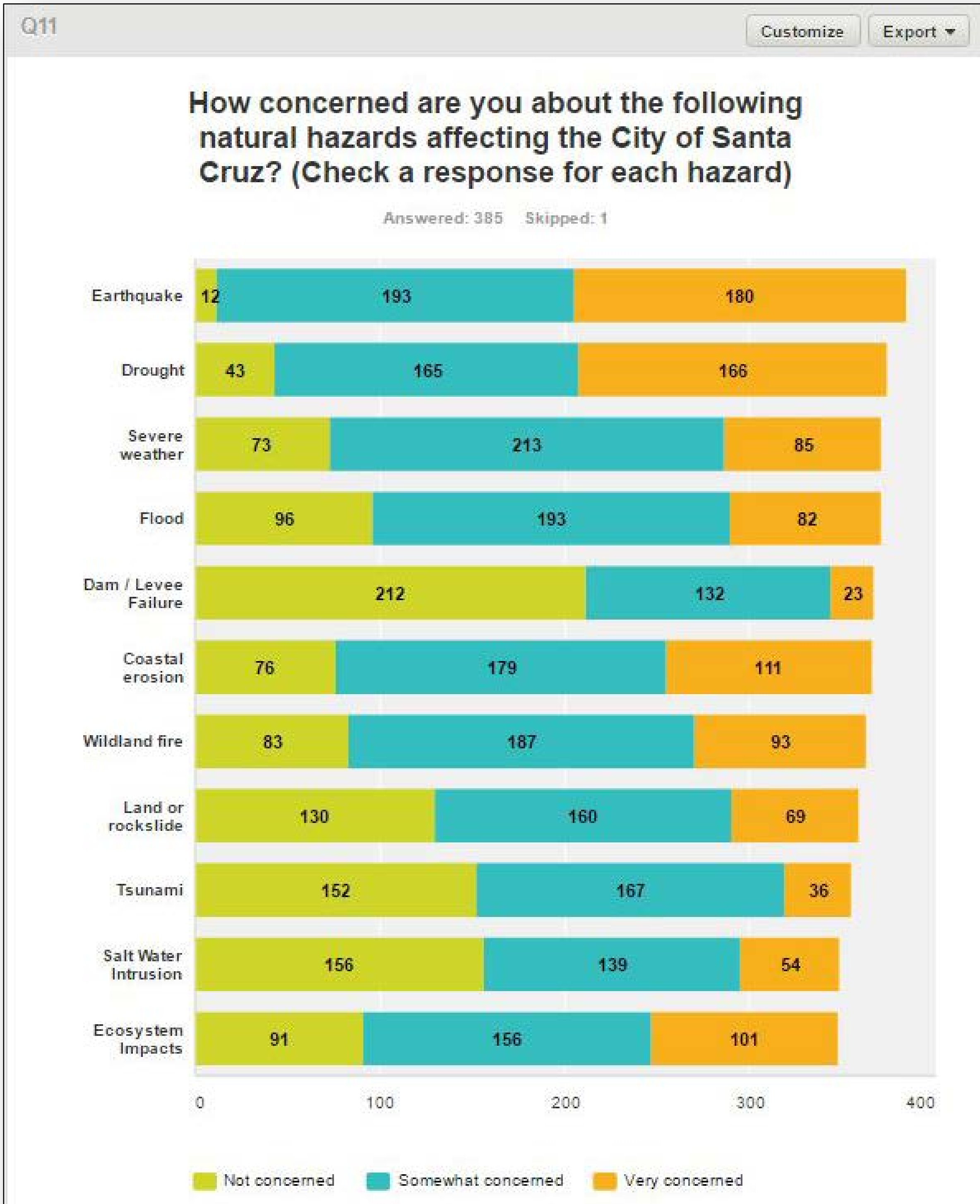
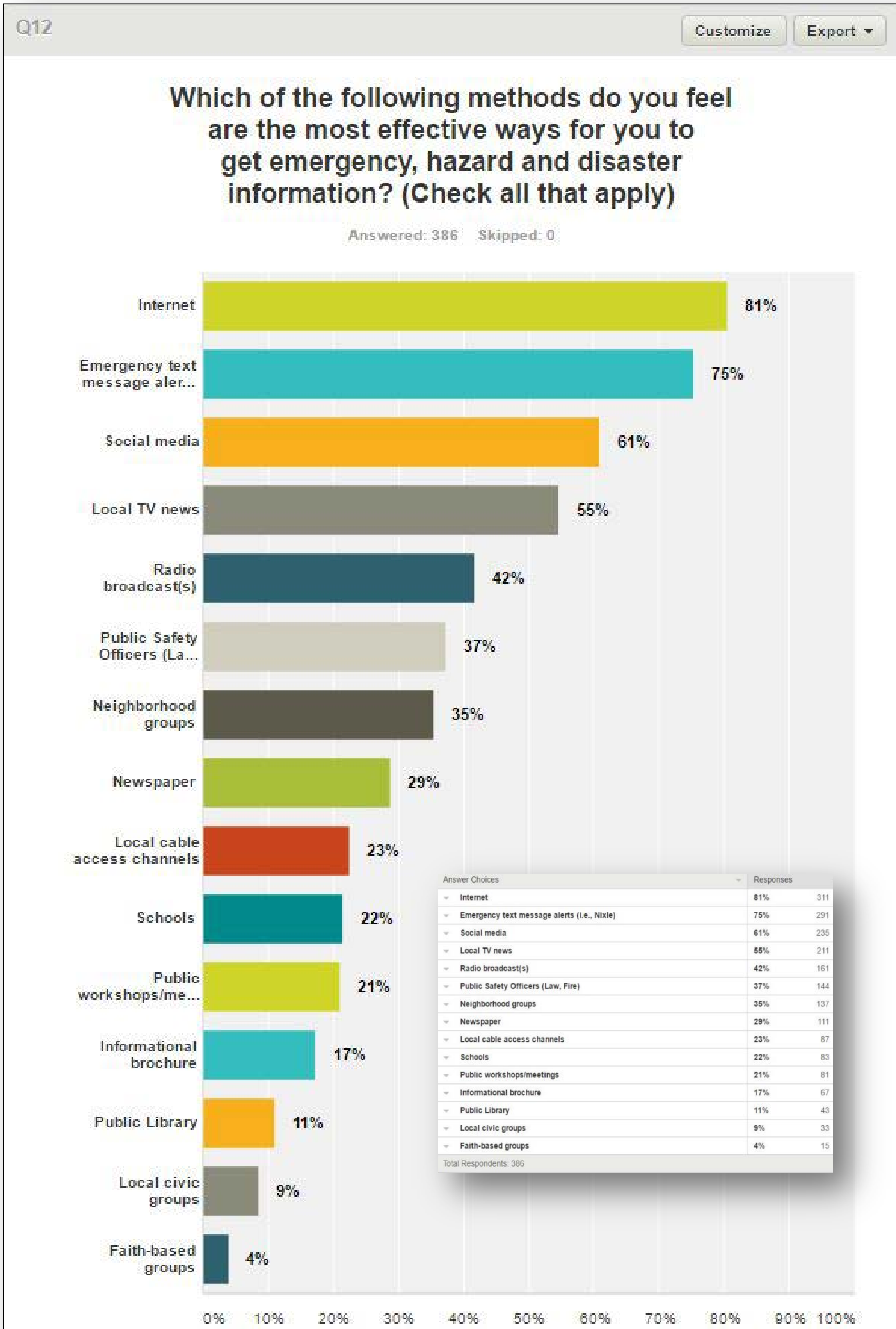
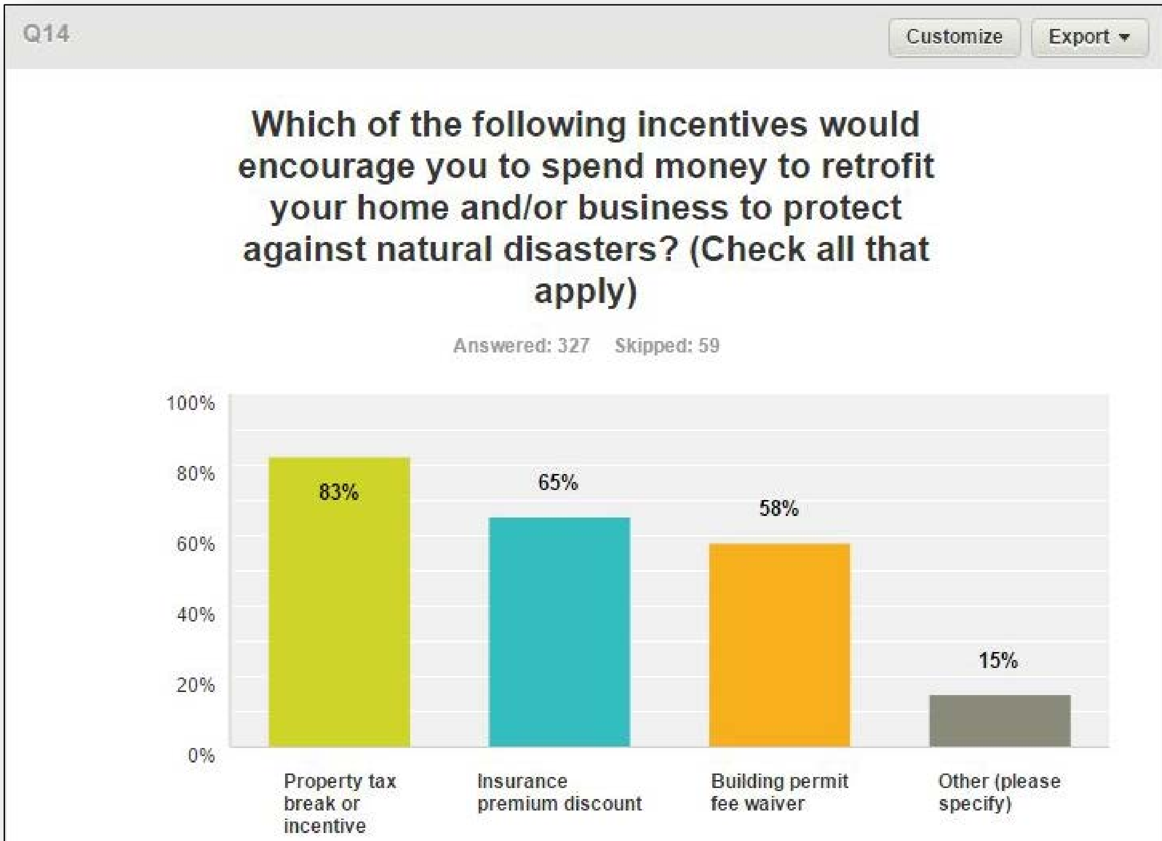


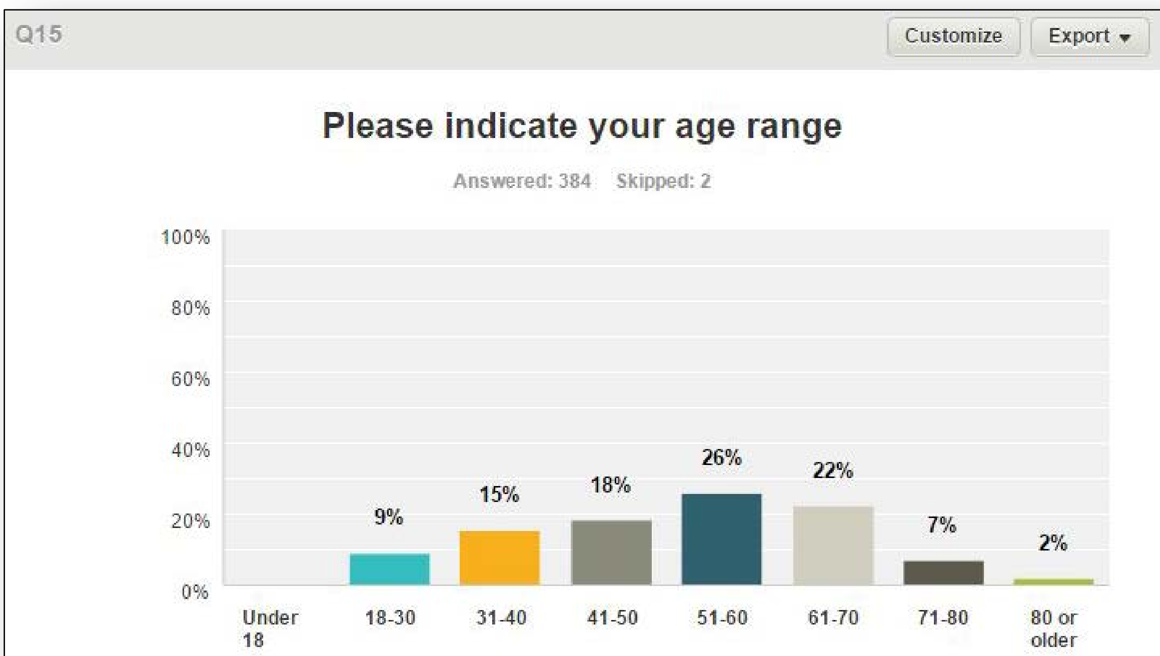
Chart Data = Number of Reponses

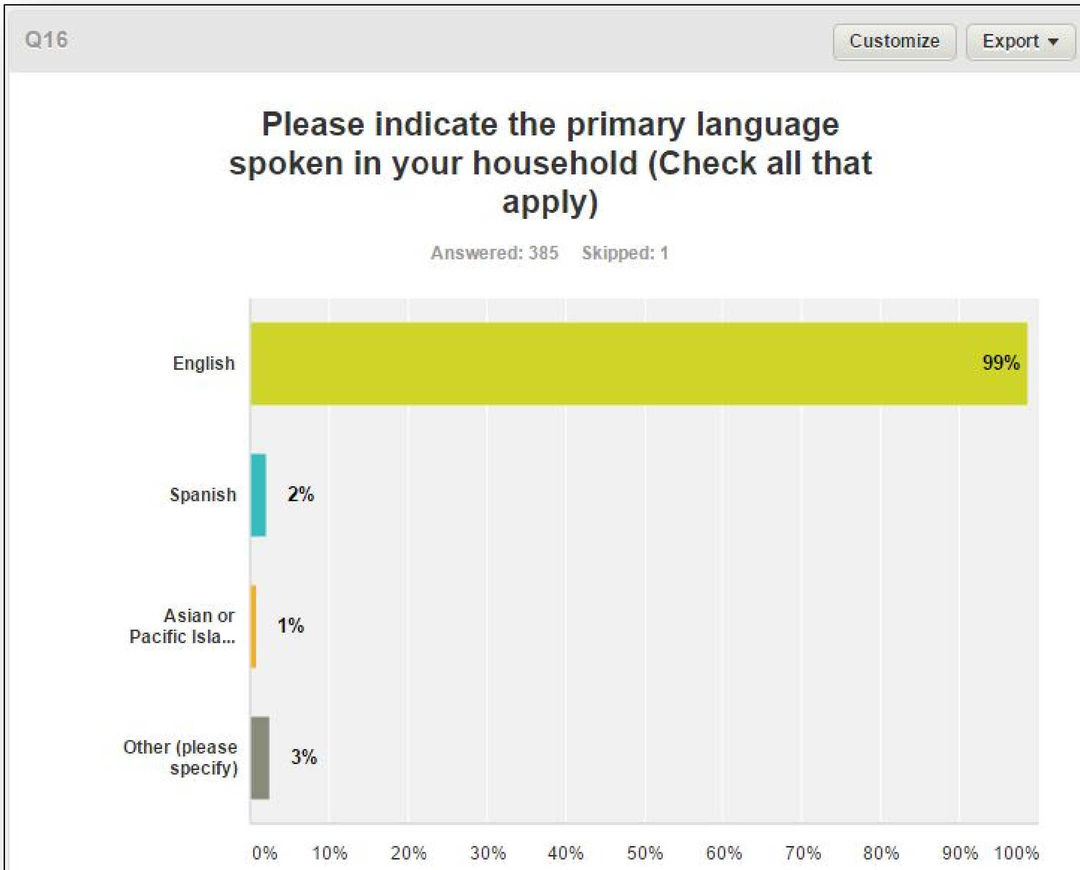


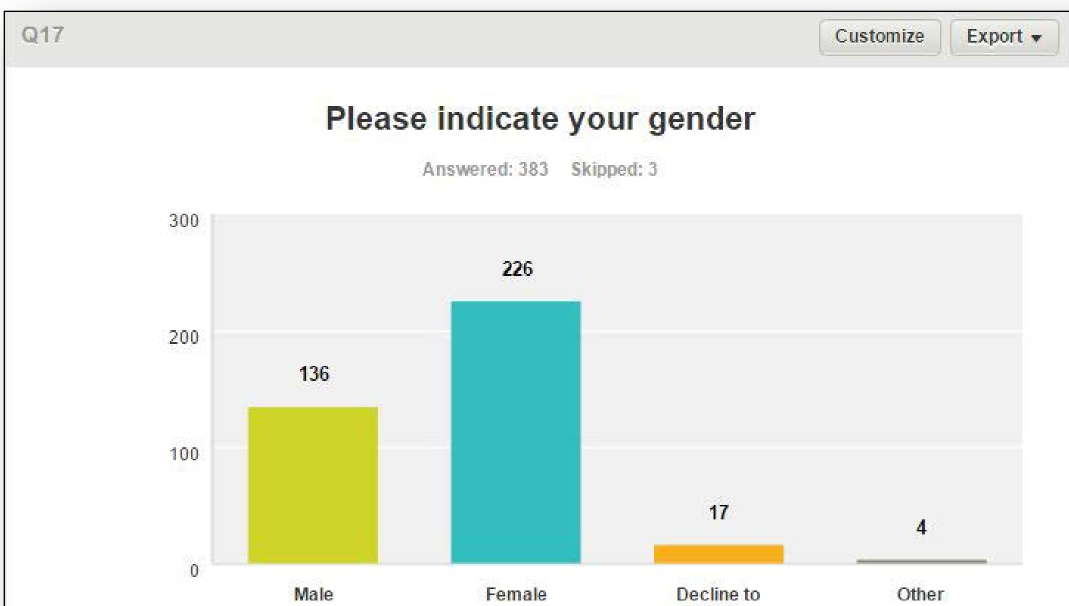
Answer Choices	Responses	
Internet	81%	311
Emergency text message alerts (i.e., Nixle)	75%	291
Social media	61%	235
Local TV news	55%	211
Radio broadcast(s)	42%	161
Public Safety Officers (Law, Fire)	37%	144
Neighborhood groups	35%	137
Newspaper	29%	111
Local cable access channels	23%	87
Schools	22%	83
Public workshops/meetings	21%	81
Informational brochure	17%	67
Public Library	11%	43
Local civic groups	9%	33
Faith-based groups	4%	15
Total Respondents: 386		

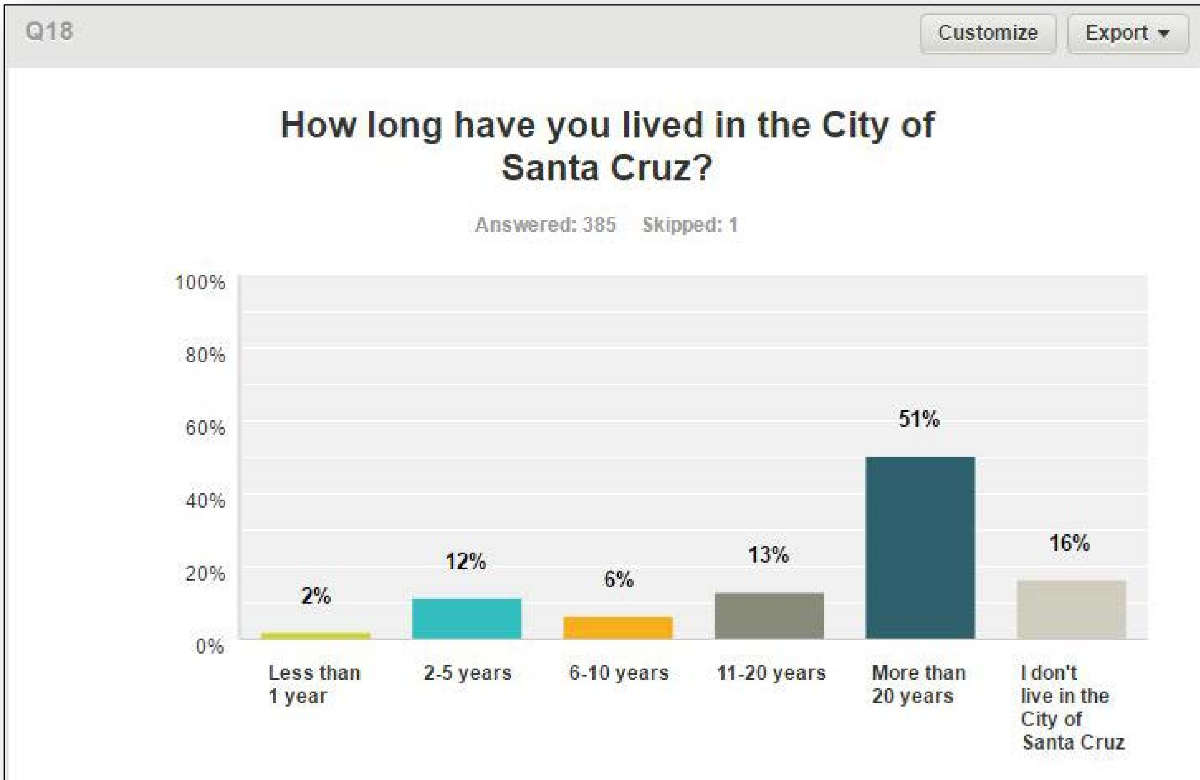
NOTE: There were 174 free form text responses. Comments in full are included within the Climate Adaptation Plan (Appendix P) The word cloud above is representative of the issues of concern and suggestions of respondents.


Q14
Customize
Export
Which of the following incentives would encourage you to spend money to retrofit your home and/or business to protect against natural disasters? (Check all that apply)
Answered: 327 Skipped: 59
100%
80%
60%
40%
20%
0%
83%
65%
58%
15%
Property tax break or incentive
Insurance premium discount
Building permit fee waiver
Other (please specify)


Q15
Customize
Export
Please indicate your age range
Answered: 384 Skipped: 2
100%
80%
60%
40%
20%
0%
9%
15%
18%
26%
22%
7%
2%
Under 18
18-30
31-40
41-50
51-60
61-70
71-80
80 or older


Q16
Customize
Export
Please indicate the primary language spoken in your household (Check all that apply)
Answered: 385 Skipped: 1
English
99%
Spanish
2%
Asian or Pacific Isla...
1%
Other (please specify)
3%
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%


Q17
Customize
Export
Please indicate your gender
Answered: 383 Skipped: 3
300
200
100
0
136
226
17
4
Male
Female
Decline to
Other



Q19

Do you have regular access to the Internet?

Answered: 385 Skipped: 1

Answer Choices	Responses	
Yes	99%	383
No	1%	2
Total		385

END OF SURVEY

A Look at the Citizen Survey Responses

- Over five times as many responses were received compared to the 2012 Citizen Survey conducted for the 2012–2017 LHMP Five Year Update (386 total responses).
- Approximately 58% of respondents own property in the City of Santa Cruz.
- The largest group of respondents (120) live in the two Westside neighborhoods which includes the Upper Westside (University) neighborhood. This area is bounded by large wildland/urban interfaces. The next largest group are from neighborhoods considered as the Eastside of Santa Cruz (65).
- The Beach Flats and Lower Ocean neighborhoods (combined) had one response. Considering that many residents in these neighborhoods are either monolingual or predominately Spanish language speakers, this result points out the need for increased outreach to our Spanish speaking community. There was a Spanish language version of the Citizen Survey available. That version garnered four responses with three coming from and Eastside neighborhood with the age of respondents from 41–70.
- 81% of respondents live *and* work in the City of Santa Cruz (292 of 360 responses).
- 80% of respondents live in the City of Santa Cruz (339)
- 92% are full-time city residents (321of 348 responses)
- 31% of respondents work outside the City of Santa Cruz.
- The largest response percentages concerning hazards experienced by respondents include:
    - Earthquakes.................... 51%
    - Severe Weather 47%
    - Flood 30%
    - Landslide/Rockslide....... 23%
    - Erosion 18%
    - Tsunami.......................... 18%
- In terms of household preparedness for natural hazards, 87% have some degree of preparedness ranging from very well prepared to adequately prepared: 51% of the total (197) respondents noted they are somewhat prepared for natural hazards; 10% are not at all prepared; and, 25% consider themselves adequately prepared.
- Concern for natural hazard impacts to residents' neighborhood shows nearly 90% as "somewhat" or "extremely" concerned.
- Only 7 (2%) respondents out of 383 had made no preparations for emergencies.
- 47% of respondents are "very concerned" with another 50% "somewhat concerned" about the effects of earthquakes. 58% were somewhat concerned about severe weather; and in the same category ("somewhat…") the numbers were: Flooding (58%), Wildland Fire (52%), Tsunami (47%), Coastal Erosion (49%) — note that this is an ongoing concern with our west coast exposure, beaches and tourist attractions; Drought (44%), Land or Rockslides (45%), and Dam/Levee Failure (36%). More information related to these responses can be found in Question 11.
- The internet was the preferred method for getting emergency information (81%) followed by: emergency text messages and alerts (75%), social media (61%), local television (55%) closely followed by Radio (42%), Public Safety Officers (37%), then, Neighborhood groups (35%) and Newspapers (29%). Interestingly but not surprisingly, web-based (including social media) was chosen as the most effective means of communication.

- Among incentives to retrofit homes against disaster, respondents preferred property tax breaks (83%), insurance premium discounts (65%) and permit fee waivers (58%).
- As for survey demographics, the largest respondent groups were 51–70 year olds (48%) and 31–50 year olds (33%). Younger respondents (18–30 years old) made were 9% of survey respondents. The remaining group (71 and older) were 7% of respondents.
- Survey respondents were 59% female and 36% male while 4% declined to specify gender. And, 80% have lived in the city more than 10 years (11–20+ years), including 51% who stated that they have lived in the city more than 20 years.
- 99% of respondents have internet access.
- Open-ended questions garnered these responses concerning reducing risk in the community:
    - Request for specific brochures in print and web-based
    - Tree removal and requiring owners to regularly maintain their trees; provide more and better information for those living in the wildland/urban interface
    - Stronger enforcement of no-camping laws
    - Improving drainage and installation of storm drains
    - Stop development in areas subject to eventual sea level rise dangers
    - Add funds for civilian (CERT) training
    - Install evacuation route signage in areas prone to flooding; road maintenance
    - Increase training for government employees who have specialized roles in the disasters and emergencies
    - Manage the forest, remove dead/old trees and augment other ecosystem protections
    - Ensure adequate water supply in the event of emergencies by maintaining the water delivery infrastructure; build an additional reservoir
    - Increase dam inspections
    - Numerous concerns voiced over transient encampments near waterways (health hazard) and camping/homeless issues in general
    - Provide meetings for the public related to preparedness

Respondents did not identify any affiliation with groups such as the Santa Cruz Neighbors. Therefore, it was not possible to distinguish how successful the outreach to that group was. As this is an update Plan, we were aware of the hazards that face the community. The profiling of those hazards was updated, including loss estimates through our GIS team member using the latest version of HAZUS, but the comments received by the public fell into categories either: (1) already known to be addressed in detail in the LHMP or, (2) comments that were irrelevant to the LHMP (such as “clean up the homeless population” or “widen the highway to reduce commute times”). We did learn that we need to be more active in producing mono-lingual Spanish language materials and will endeavor to do so in upcoming and future publications and outreach.

Local Hazard Mitigation Plan Placed at Main Branch Library for Public Review and Comment

HAZARD MITIGATION PLAN

*** Requires Citizen Review & Comments ***

The City of Santa Cruz **Local Hazard Mitigation Plan** is being updated for submittal to the Federal Emergency Management Agency.

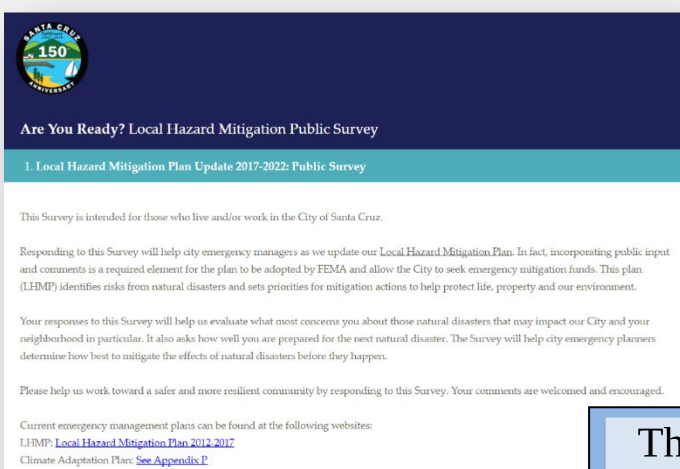
When FEMA approves the plan the city will become eligible to compete for money to fund projects that will help limit the damages from future natural disasters.

Please:

- Read this Local Hazard Mitigation Plan (LHMP)
- The entire LHMP is also on the City of Santa Cruz website at this location: http://www.cityofsantacruz.com/home/showdocument?id=34606
- The Appendices to the LHMP are on these web pages: http://www.cityofsantacruz.com/home/showdocument?id=36530 and http://www.cityofsantacruz.com/home/showdocument?id=36529

Comments:

- You can comment a number of ways:
  - By email to rsolick@cityofsantacruz.com
  - Take our **Citizen Survey** by going to this web page: https://www.surveymonkey.com/r/LHMP_SURVEY
    - Survey responses are confidential



Are You Ready? Local Hazard Mitigation Public Survey

1. Local Hazard Mitigation Plan Update 2017-2022: Public Survey

This Survey is intended for those who live and/or work in the City of Santa Cruz.

Responding to this Survey will help city emergency managers as we update our Local Hazard Mitigation Plan. In fact, incorporating public input and comments is a required element for the plan to be adopted by FEMA and allow the City to seek emergency mitigation funds. This plan (LHMP) identifies risks from natural disasters and sets priorities for mitigation actions to help protect life, property and our environment.

Your responses to this Survey will help us evaluate what most concerns you about those natural disasters that may impact our City and your neighborhood in particular. It also asks how well you are prepared for the next natural disaster. The Survey will help city emergency planners determine how best to mitigate the effects of natural disasters before they happen.

Please help us work toward a safer and more resilient community by responding to this Survey. Your comments are welcomed and encouraged.

Current emergency management plans can be found at the following websites:
LHMP: Local Hazard Mitigation Plan 2012-2017
Climate Adaptation Plan: See Appendix P

Thank you for your interest and comments!

Request for Review by Emergency Management Partners

On the following pages are scanned images of letters and email correspondence sent to, or received from, our community emergency management partners and others requesting their review and comment on the LHMP. Where appropriate and relevant, their corrections, suggestions and additions (also included) have been incorporated into the body of the LHMP.

List of Outreach materials to Emergency Stakeholders and Citizens

- Letter to County of Santa Cruz Emergency Management Council requesting peer and stakeholder review and comment on DRAFT LHMP (April 27, 2017)
- Screenshots of website posting of City Facebook page requesting input on posted "Are You Ready? Local Hazard Mitigation Public Survey" (originally adapted from King County, WA, LHMP outreach) (April 14, 2017)
- Email to Santa Cruz Neighbors requesting they share the Citizen Survey with their members throughout the city. (March 22, 2017)
- Email from Santa Cruz Neighbors to members requesting feedback on the draft LHMP. (May 11, 2017)
- Citizen Survey: "Are You Ready? Local Hazard Mitigation Public Survey" (Complete survey and responses are provided above.)
- Email (with attachment) to County of Santa Cruz Office of Emergency Services requesting peer review of LHMP at 95% completion (July 18, 2017)

Request to Santa Cruz County Emergency Management Council for peer and stakeholder review and comment
April 27, 2017
County of Santa Cruz Emergency Management Council Agenda —

CITY OF SANTA CRUZ

PUBLIC WORKS DEPARTMENT
809 Center Street, Room 201, Santa Cruz, CA 95060 • 831 420-5160 • Fax: 831 420-5161

April 27, 2017

TO: Santa Cruz County Emergency Management Council

RE: Local Hazard Mitigation Plan Update: Peer and Citizen Review

The City of Santa Cruz needs your assistance in completing the 2017–2022 update to our Local Hazard Mitigation Plan. Our current 2012 FEMA-approved plan allows the city to compete for pre-disaster mitigation funding. Based on FEMA's five-year update requirement, we are reviewing and revising our LHMP and are asking for your peer review and comments on the DRAFT document. The Plan details hazards and risks and includes objectives, goals and specific actions that in turn provide direction for future mitigation activities.

A FEMA requirement for adoption of an LHMP is that it be widely disseminated and reviewed among stakeholders and within the community and, that it be reviewed during its development. Further, opportunities need to be provided for comment in a variety of settings — online, via surveys, at public meetings and through peer review. As jurisdictional stakeholders you are the emergency management partners that either work for, or assist, the City of Santa Cruz during disasters by providing direct support, mutual aid or other significant collaboration.

Stakeholder/Partner Review

- PDF versions of the DRAFT LHMP will be made available early in May 2017 (by email) for your review and comment.
- Your review should encompass the overall plan and, your comments should focus on how well the LHMP addresses local hazards and mitigation strategies. Your unique perspective as emergency management partners and mutual aid responders is valuable in completing and enhancing this Plan.

Deadline

We would appreciate having your comments back to me no later than June 2, 2017. Contact information is below. Our intention is to have the LHMP submitted to CalOES, for initial approval, by the end of July or early August.

Thank you for taking the time to review this important material and for returning your comments to me. My contact information is included below.

Sincerely,

Robert Solick

Robert Solick
LHMP PROJECT MANAGER
Management Professional and Technical Assistant
809 Center Street, Room 201• Santa Cruz, CA 95060
831-420-5169 • *email*: rsolick@cityofsantacruz.com

Presentation requesting peer and emergency managers' review of LHMP
May 4, 2017

County of Santa Cruz

EMERGENCY MANAGEMENT COUNCIL
Tel: (831) 454-2188 Fax: (831) 454-2350

Meeting: May 4, 2017
Time: 2:00–4:00 p.m.
Location: EOC—5200 Soquel Ave. Building C 2nd floor Santa Cruz, Ca 95062

AGENDA

1.0 Call to Order/Introductions
2.1 Roll Call (*Emergency Management Council Appointed Members*)
- 2.2 Attendees:
- 2.3 Absent:
- 2.4 Absent with Notice: Patrick Goff, Rosemary Anderson, Brian Sherin

3.0 Additions and Deletions to the Agenda
4.0 Approval of Minutes: N/A
5.0 Correspondence (*All*)
6.0 Oral Communications: *Regarding items not on the Agenda*
7.0 Presentation: None scheduled
8.0 New Business:
9.1 Informational Reports
- 9.2 County Office of Emergency Services/Update
  We are in the process of planning for a table top exercise on July 7 with a focus on mass care and sheltering. We will be inviting EMC members to participate.
- 9.3 City Reports
  - 9.3.1 Capitola ....*Captain Tom Held*
  - 9.3.2 Santa Cruz ....*Paul Horvat/Robert Solick --EMC review of SC City LHMP*
  - 9.3.3 Scotts Valley ....*Lt. John Wilson*
  - 9.3.4 Watsonville..........*Chief Pablo Barreto*
- 9.4 Grant Updates
  - 9.4.1 2015 State Homeland Security Grant –detailed project status as of 5/30/17 is due to us by 6/15/17 (Santa Cruz PD and Scotts Valley PD)
  - 9.4.2 2016 State Homeland Security Grant – approved 4.11.2016 – funding letters will be sent out by end of May.
  - 9.4.3 2017 State Homeland Security Grant – submitted, waiting for State approval

10.0 Citizen Corps Council
- 11.1.1. CERT ....Todd Skrabak
- 11.1.2. Medical Reserve Corp ....*Dave Newell*
- 11.1.3. ARES ....*Cap Pennell*
- 11.1.4. Equine Evacuation..........*Donna Stidolph/Kali Haber*
- 11.1.5. Volunteer Organizations Active in Disasters (VOAD) ....*Jim Uhey*
- 11.1.6. County Office of Education..........*Jim Howes*

11.0 Announcements (*All*)
12.0 Items for future meetings
13.0 Adjourn
14.0 Next Meeting: September 7, 2017 2-4 PM Location: EOC

For information on the Emergency Management Council use the following link:
Santa Cruz County Code: EMC

Request to Santa Cruz Neighbors for residents review and comment
March 22, 2017

Wed 3/22/2017 10:34 AM

Robert Solick

City of Santa Cruz Needs Your Members Help with Disaster Planning

To [redacted]arthlink.net'

Cc 'email@santacruzneighbors.com'

Hello Deborah,

The City of Santa Cruz is working on a **Five Year Update to our Local Hazard Mitigation Plan**. It is a FEMA requirement that the public has an opportunity to comment on the Plan and that we incorporate citizen concerns and comments into the Plan. With that in mind, we are asking for your group's help in getting the Citizen Survey: "Are You Ready?" to your members for their review and comment.

To increase our outreach to the public, it would be a great help to us if you make our Survey available on your website, and social media pages via your email list, or in any other ways you can to get this to your members.

Here is some suggested text you can use to introduce the survey to your City of Santa Cruz members.

> **Help Santa Cruz Prepare for Disasters Before They Happen**
> **Take the Survey: "Are You Ready?"**
>
> The City of Santa Cruz is asking residents to help them update the Local Hazard Mitigation Plan. The Plan identifies risks from natural disasters in order is to reduce the impacts to life, property and the environment from natural disasters when they occur. When the Plan is adopted by the state and FEMA the City can compete for grant funding to help prevent and reduce risks and vulnerabilities in your neighborhood.
>
> Please help the City of Santa Cruz work towards a safer and more resilient community by responding to their survey. Your comments are welcomed and encouraged. Responses are anonymous. To take the survey click this link: Citizen Survey - Are You Ready?

Thank you. You can contact me with any questions you or your members may have. We value your input!

Robert Solick

Robert Solick
Project Manager
City of Santa Cruz
Local Hazard Mitigation Plan: Update
831-420-5169 (w)

Santa Cruz Neighbors is a city-wide 501(c)3 nonprofit organization representing a network of neighborhoods which partners with educational institutions, local government, local businesses, and non-profits dedicated to safer neighborhoods, community oriented government and provides a neighborhood voice for the residents of Santa Cruz. (Santa Cruz Neighbors)

County of Santa Cruz OES/Emergency Services Manager Review
July 20, 2017

COUNTY OF SANTA CRUZ

OFFICE OF EMERGENCY SERVICES
5200 Soquel Ave., Building C 2nd Floor
Santa Cruz, CA 95062-7800
(831) 454-2715

July 20, 2017

Robert Solick
LHMP Project Manager
809 Center Street, Room 201
Santa Cruz, CA 95060

Re: County Review of Santa Cruz City LHMP (Five Year Update)

Dear Robert,

Per your request to the Emergency Management Council Members and myself, I have reviewed the City of Santa Cruz' Local Hazard Mitigation Plan (LHMP) Five Year Update. I want to first acknowledge and commend the City of Santa Cruz for its participatory and inclusive planning process and for the presentation of the draft plan to our Emergency Management Council members at the May 4, 2017 meeting.

Below are a couple of minor observations noted in the review of the City of Santa Cruz' LHMP update:

- In the Mitigation Plan Objective and Actions section as well as the Mitigation Plan Primary Goals; the plan uses the word '*avoid*' as it relates to disasters and subsequent goals. You outline and illustrate the ways in which you would reduce and mitigate; language more conducive to planning as one cannot realistically '*avoid*' such happenstances.
- There is more current census data available than the 2013 statistics cited in the Community Profile section.

The Five Year update provides comprehensive updates to vulnerability assessment, Climate Adaptation Input, and a clear plan providing for long term measures to reduce the impacts of future disasters. Should you require and further assistance from my office, please do not hesitate to contact me.

Thank you,

Rosemary Anderson

Rosemary Anderson, Emergency Services Manager
County of Santa Cruz Office of Emergency Services

Cc: Nancy C. Gordon, County of Santa Cruz General Services Director

Additional comments received:

- Patrick Goff, P.E. • Executive Director •Environmental Health and Safety Office of Emergency Services • University of California, Santa Cruz

City of Santa Cruz
Local Hazard Mitigation Plan Update: Facebook Posting of Citizen Survey
March 24, 2017

Below is a screenshot of the City of Santa Cruz Government Facebook page showing the posting (March 24, 2017) of the *Are You Ready? Local Hazard Mitigation Public Survey*. Note that the posting has a link for a Spanish language version of the survey

Santa Cruz Neighbors requests members to respond to the Citizen Survey
May 11, 2017

From:
Sent: Thursday, May 11, 2017 12:55 PM
To:
Subject: IMPORTANT - Please fill out for City EMERGENCY Managers

Responding to this Survey will help city emergency managers as we update our Local Hazard Mitigation Plan. In fact, incorporating public input and comments is a required element for the plan to be adopted by FEMA and allow the City to seek emergency mitigation funds. This plan (LHMP) identifies risks from natural disasters and sets priorities for mitigation actions to help protect ... life, property and our environment.
Your responses to this Survey will help us evaluate what most concerns you about those natural disasters that may impact our City and your neighborhood in particular. It also asks how well you are prepared for the next natural disaster. The Survey will help city emergency planners determine how best to mitigate the effects of natural disasters before they happen.
Please help us work toward a safer and more resilient community by responding to this Survey. Your comments are welcomed and encouraged.

GOTO:

http://www.cityofsantacruz.com/Home/Components/News/News/5427/

OR

Fill out ATTACHMENT and email to: rsolick@cityofsantacruz.com

Santa Cruz Neighbors, Inc.

15 years of Neighbors Helping Neighbors

www.santacruzneighbors.org
email@santacruzneighbors.org

LIKE and follow us on Facebook
https://www.facebook.com/santacruz.neighbors
Join your own Neighborhood at Nextdoor.com

Endnotes

1 City of Santa Cruz General Plan Safety Element October 25, 1994

2 City of Santa Cruz Downtown Recovery Program- Adopted 1991

3 UCSC LRDP (Long Range Development Plan) 2005–2020

4 http://lrdp.ucsc.edu/MonitoringReports/2015-16_Settlement_Report.pdf (http://lrdp.ucsc.edu/)

5 UCSC LRDP 2005–2020

6 Seismicity of the United States, 1568-1989 (Revised) by Carl W. Stover and Jerry L. Coffman, U.S. Geological Survey Professional Paper 1527, US Government Printing Office, Washington: 1993.

7 https://earthquake.usgs.gov/

8 https://www2.usgs.gov/science/science.php?term=302

9 https://www.ce.washington.edu/research/areas/geotechnical

10 http://eps.ucsc.edu/

11 http://eps.ucsc.edu/

12 Estimation of Future Earthquake Losses in California

13 http://www.conservation.ca.gov/cgs/rghm/loss/Pages/2016_Analysis.aspx

14 California Coastal Commission ReCAP Pilot Project Findings and Recommendations: Monterey Bay Region

15 Wildland Pre-Suppression Plan for the Mutual Threat Zone Areas; September 1990 Santa Cruz Fire Department and California Department of Forestry.

16 FEMA Flood Insurance Study Number 06087CV000A; March 2, 2006, Page 15

17 http://nwis.waterdata.usgs.gov/ca/nwis/peak

18 (Stormwater Public Works)

19 California Coastal Commission ReCAP Pilot Project Findings and Recommendations: Monterey Bay Region

20 Tsunamis Affecting the West Coast of the United States 1806-1992 NOAA (Dec 1993)

21 The Tsunami Hazard in California, California Seismic Safety Commission (Dec 2005)

22 Inundation maps for the State of California, Richard K Eisner, Jose C. Borrero, and Costas E. Synolakis (Governor’s Office of Emergency Services).

23 Inundation maps for the State of California, Richard K Eisner, Jose C. Borrero, and Costas E. Synolakis (Governor’s Office of Emergency Services).

24 San Jose Mercury News Little is known about damage giant wave could cause By Glennda Chui (June 25, 2005)

25 California Coastal Commission ReCAP Pilot Project Findings and Recommendations: Monterey Bay Region

26 Evaluation of Erosion hazards - Heinz Center Coastal Erosion Mapping and Management - Journal of Coastal Research)

27 Draft Review of California Coastal Erosion Planning and Response: A Strategy for Action Gary D. Nichols, California Resources Agency March 2003

28 Living with The Changing California Coast by G.B. Griggs, K, Patsch and L. E. Savoy- University of California Press

29 California Coastal Commission ReCAP Pilot Project Findings and Recommendations: Monterey Bay Region

30 City of Santa Cruz General Plan

31 https://www.ready.gov/landslides-debris-flow

32 Santa Cruz County Office of Emergency Services

33 City of Santa Cruz 2005 Urban Water Management Plan, February 2006

34 City of Santa Cruz 2005 Urban Water Management Plan, February 2006

35 http://landslides.usgs.gov/

Local Hazard Mitigation Plan

2020 Five Year Update

DRAFT

Local Hazard Mitigation Plan
2020 Five Year Update

Prepared by

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Acknowledgements

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1 Chapter One - Introduction

Natural hazards and extreme weather events are an ongoing part of the cycle of weather and seasons. However, when natural hazards such as earthquakes, tsunamis or coastal storms are at their height, they pose severe risk to people and property. They can cause death or leave people injured or displaced, cause significant damage to our communities, businesses, public infrastructure and environment, and cost tremendous amounts in terms of response and recovery dollars and can contribute to economic loss.

In March 2011, the City of Capitola experienced significant rain events that caused a catastrophic failure of a storm drain, resulting in flooding of the Capitola Village. Damages associated with this flooding were estimated at approximately $4 million in the City of Capitola and $15 million dollars countywide, damaging many business and City facilities. In response to this event, the City pursued grant funding to prepare their first Local Hazard Mitigation Plan (LHMP or the Plan), which was completed in May of 2013.

The Disaster Mitigation Act of 2000 (DMA, Section 201.6(c)(4)(i) requires a Plan Maintenance Process which includes periodically reviewing and updating hazard mitigation plans. FEMA requires jurisdictions to update their LHMP every five years, subject to approval by the California Office of Emergency Services (CalOES). An approved and adopted LHMP is required to receive future federal and state emergency funding.

This document is the City of Capitola 2020 LHMP Five Year Update. It is the first update undertaken by the City.

The intent of the current Plan, while incorporating much of the prior LHMP versions, is to:

- Include any newly identified hazards
- Update hazards/risk data
- Update development data
- Review and revise as necessary the hazard mitigation goals and actions
- Update demographic data and maps
- Incorporate the City of Capitola Coastal Change Vulnerability Report (June 2017)

A successful hazard mitigation strategy enables the implementation and sustaining of local actions that reduce vulnerability and risk from hazards, or reduce the severity of the effects of hazards on people and property. Historically, in many local jurisdictions, disasters are followed by repairs and reconstruction which simply restore the area to pre-disaster conditions. Capitola has experienced many natural hazard events during its history (Appendix A – Timeline of Capitola Natural Hazard Events). Such efforts expedite a return to normalcy; however, the replication of pre-disaster conditions results in a cycle of damage, reconstruction, and repeated damage. Hazard mitigation ensures that post-disaster repairs and reconstruction result in a true reduction in future hazard vulnerability.

While we cannot prevent disasters from happening, their effects can be reduced or eliminated through a well-organized public education and awareness effort, preparedness activities and mitigation actions. For those hazards which cannot be fully mitigated, the community must be prepared to provide efficient and effective response and recovery. As a coastal community, the City of Capitola has historically experienced extreme wave surges, coastal storms, and flooding on a cyclical basis. In addition, Capitola is near the San Andreas earthquake fault line, and is at risk from tsunami, and a variety of other natural disasters. This Plan outlines opportunities to increase Capitola's resiliency in the face of future natural hazards.

1.1 Purpose of the Plan

As the cost of damages from natural disasters continues to increase, the City of Capitola understands the importance of identifying effective ways to reduce vulnerability to disasters. This Plan assists Capitola in reducing vulnerability to disasters by identifying critical facilities (Appendix B – Detailed Critical Facilities Inventory), resources, information, and strategies for risk reduction, while helping to guide and coordinate mitigation actions.

The Plan provides a set of strategies intended to do the following: reduce risk from natural hazards through education and outreach programs, foster the development of partnerships, and implement risk reduction activities.

The resources and information within the Plan:

- Establish a basis for coordination and collaboration among participating agencies and public entities;
- Identify and prioritize future mitigation projects; and
- Assist in meeting the requirements of federal assistance programs.

The Capitola Hazard Mitigation Plan works in conjunction with other plans, including the General Plan, Local Coastal Plan, and Emergency Operations Plan.

1.2 Authority

The Disaster Mitigation Act of 2000 (DMA 2000), Section 322 (a-d) requires that local governments, as a condition of receiving federal disaster mitigation funds, have a mitigation plan that describes the process for identifying hazards, risks and vulnerabilities, identifies and prioritizes mitigation actions, encourages the development of local mitigation and provides technical support for those efforts. This Plan serves to meet these requirements.

1.3 Plan Adoption

The City of Capitola will use a resolution to adopt the local hazard mitigation plan (see sample below).

1.4 Plan Use

Each section of this Plan provides information and resources to assist people in understanding the hazard-related issues facing residents, businesses, and the environment. The structure of the plan enables people to use a section of interest to them and allows the City of Capitola to review and update sections when new data is available. The ability to update individual sections of the mitigation plan places less of a financial burden on the City. Decision makers can allocate funding and staff resources to selected pieces in need of review, thereby avoiding a full update, which can be costly and time consuming. The ease of incorporating new data will result in a Plan that remains current and relevant to Capitola.

The Plan is comprised of the following chapters:

Chapter 1: Introduction
The Introduction describes the background and purpose of developing the mitigation plan in addition to introducing the mitigation priorities and summarizing the planning process.

Chapter 2: Community Profile
The Community Profile presents the history, geography, demographics, and socioeconomics of Capitola. It serves as a tool to provide a historical perspective of natural hazards in the City.

Chapter 3: Hazards Assessment
This chapter provides information on hazard identification, hazard profiles, vulnerability and risk associated with natural hazards, and a vulnerability assessment of critical facilities in relation to the identified hazards.

Chapter 4: Mitigation Actions
This chapter provides strategies and mitigation actions to reduce potential risks to Capitola's critical facilities, residents, and businesses.

Chapter 5: Plan Maintenance/ Capabilities
This chapter provides information on plan implementation, monitoring and evaluation, discusses the assets and capabilities available to achieve the proposed mitigation actions outlined in Chapter 4, and opportunities for continued public involvement.

1.5 Change in Priorities

Subsequent to adoption of the 2013 LHMP, there has been no change in the hazard rankings. However, several technical studies related to sea level rise have been prepared, including most notably the City of Capitola Coastal Climate Change Vulnerability Report (June 2017). This report provides a detailed assessment of the potential impacts of sea level rise and recommended measures to minimize its impact. These measures have been incorporated into Table 37: Capitola Hazard Mitigation Actions.

With respect to the other mitigation actions identified in Table 37: Capitola Hazard Mitigation Actions, the General Plan was adopted in 2014. It includes a Safety and Noise element, providing further guidance on hazard-related issues and policy direction. The City also made improvements to the Noble Gulch storm drain facilities and completed and evaluation of the likelihood of debris flow impacts to the Stockton Avenue bridge during a catastrophic flooding event.

City staff continue to work in close coordination with other jurisdictions and agency to address local and regional hazards. In particular, the City has been working with the Soquel Creek Water District to construct and implement the Pure Water Soquel, Groundwater Replenishment and Seawater Intrusion Prevention Project. This includes plans to construct a new Seawater Intrusion Prevention Well on Monterey Avenue.

1.6 Mitigation Priorities and Goals

The purpose of the Capitola Local Hazard Mitigation Plan is to promote sound public policy designed to protect citizens, critical facilities, infrastructure, private property, and the environment from natural hazards. This can be achieved by increasing public awareness, documenting the resources for risk reduction and loss-prevention, and identifying activities to guide the City toward building a safer, more sustainable community.

Sample City Council Resolution

RESOLUTION ADOPTING A LOCAL HAZARD MITIGATION PLAN FOR THE City of Capitola:

WHEREAS, the Disaster Mitigation Act of 2000, as amended, requires that state and local governments, tribal nations and other eligible applicants develop and adopt hazard mitigation plans in order to receive certain federal assistance, and

WHEREAS, the City of Capitola having developed a Local Hazard Mitigation Plan Five Year Update meeting the requirements of Section 409 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988, and Section 322 of the Disaster Mitigation Act of 2000 (DMA 2000); and

WHEREAS, the DMA 2000 requires all cities, counties, and special districts to adopt a Local Hazard Mitigation Plan, and to update that plan at lease every five years as a condition of future funding for disaster mitigation from multiple FEM pre- and post-disaster mitigation grant programs; and

WHEREAS the City of Capitola seeks to maintain and enhance both a disaster-resistant and resilient city reducing the potential loss of life, property damage, and environmental degradation from natural disasters, which accelerating economic recovery from those disasters.

NOW THEREFORE, BE IT RESOLVED that the City of Capitola does hereby adopt the City of Capitola 2019-2024 Local Hazard Mitigation Plan Five Year Update as an official plan in accordance with the federal Disaster Mitigation Act of 2000, thereby meeting the continued eligibility requirements for the potential receipt of hazard mitigation grant funds; and

Be if further resolved that the City of Capitola will submit this Adopted Resolution to the Federal Emergency Management Agency Region IX Mitigation Division IX official to enable the plan’s final approval

ADOPTED by the City Council this ___ day of ____________________, 2020.

APPROVED:

____

(Title, Name)

____

(Title, Name)

The four primary goals for reducing disaster risk in Capitola include:

1. Avoid or reduce the potential for loss of life, injury and economic damage to Capitola residents from earthquakes, floods, drought, tsunami, coastal erosion/ bluff failure, and other geological hazards.
2. Increase the ability of the City government to serve the community during and after hazard events.
3. Protect Capitola's unique character, scenic beauty and values from being compromised by hazard events.
4. Encourage mitigation activities to increase the disaster resilience of institutions, private companies and systems essential to a functioning City of Capitola.

1.8 Hazard Mitigation Planning Process

This document is the first update to the Local Hazard Mitigation Plan pursuant to the Disaster Mitigation Act of 2000 for the City of Capitola. The primary City staff developing, maintaining, and implementing this plan comprise the Hazard Mitigation Planning (HMP) Team. Members of this team represent the following City Departments:

- Public Works Department
- City Manager's Office
- Police Department
- Community Development Department
- Kimley-Horn & Associates (Consultants)

1.8.1 2020 Capitola LHMP Update

In 2018, the City initiated the planning effort to update the 2013 LHMP. The LHMP team identified characteristics and potential consequences of natural hazards that are a potential threat to the City of Capitola. With the understanding of the risks posed by the identified hazards, the team determined and reviewed previously listed priorities and assessed various methods to avoid or minimize any undesired effects. Recent historical incidents were noted and assessed. Responsible departments were consulted in the review and development of the goals, objectives and actions. As a result, the mitigation strategy, including goals, objectives and actions, were determined, followed by an implementation and monitoring plan. This monitoring plan included tracking of hazard mitigation projects, changes in day-to-day City operations, and continued hazard mitigation development.

Local Capabilities Assessment and Integration

This assessment of the mitigation goals, programs and capabilities included a review of the following items:

- Human and technical resources
- Financial resources and funding sources
- Local ordinances, zoning and building codes
- On-going plans and projects

Consistency with other City plans, programs and policies were reviewed by consulting with the respective City departments. This included a review of the City's 2014 General Plan, Local Coastal Plan, and Emergency Operations Plan.

Agency and Stakeholder Coordination

On February 28, 2019, the City of Capitola held a meeting inviting agencies and stakeholders that were involved in preparation of the 2013 LHMP to inform them about the 2020 LHMP update process and to seek their input regarding hazards and hazard planning for Capitola. The invitation was sent to the following organizations identified in Table 1: 2020 LHMP Agency and Stakeholder Contact List.

Table 1: **2020 LHMP Agency and Stakeholder Contact List**

Name	Organization	Title
Jamie Goldstein	City of Capitola	City Manager
Susan Westman	City of Capitola	Interim Community Dev. Director
Steve Jesberg	City of Capitola	Public Works Director
Michael Card	City of Capitola	Chief of Police
Tom Held	City of Capitola	Captain
Larry Laurent	City of Capitola	Information Technology
Carolyn Flynn	City of Capitola	LHMP Coordinator
Scotty Douglas	Santa Cruz Regional 911	General Manager
Paul Horvatt	County of Santa Cruz	Emergency Services Manager
Kevin C. Cole	Soquel Creek Water District	Field Crew Supervisor/ Safety
Shelley Flock	Soquel Creek Water District	Staff Analyst
Paul Rucker	Soquel Union Elementary School District	Director of Maintenance and Operations
Jeff Maxwell	Central Fire Protection District of Santa Cruz County	Chief/Battalion Chief
Tom Evans	National Weather Service Forecast Office, NOAA	Warning Coordination Meteorologist
Patsy Hernandez	Red Cross	
Charles Bockman	California State Parks	Parks Superintendent
Don Hill	SC County Public Works & Flood Control & Water Conservation District (Zone 5)	Assistant Director, Public Works
Rachel Lather	Santa Cruz County Sanitation District	Senior Civil Engineer
Wendy Abbott Sarsfield	PG&E	Central Coast Government Relations
Bill Wiseman	Kimley-Horn & Associates	Project Consultant

The meeting was attended by representatives from the City of Capitola, Soquel Union Elementary School District, and PG&E. Comments included general questions about the update process and schedule and subsequent coordination needs. PG&E wanted to confirm that fire hazards would be addressed in the plan, which was confirmed.

The Public Review Draft 2020 LHMP was also emailed to the above listed organizations on April 12, 2020 requesting they review document and send any comments to Steve Jesberg by April 29, 2020. No comments were received.

Public Involvement

When the 2020 Draft LHMP update was completed, a 14-day public comment period was initiated by posting the document to the City's web site on April 15, 2020, and requesting comments be submitted to the Public Works

Director by April 29, 2020. Copies were also made available at City Hall. A copy of the notice posted on the City's website is shown in Appendix D.

The only comment received was a letter from the Surfrider Foundation, dated April 29, 2020. In summary, the letter recommended adapting to sea level rise with modalities that preserve the coast; such as living shorelines, soft armoring techniques, and relocation of development within coastal hazard zones. They recommended against implementing the jetty improvement project, identifying alternative options for beach replenishment, and preparing a comprehensive, long-term proactive management plan to protect Depot Hill in a way that preserves the natural coastline and avoids hard armoring. To address these issues, Mitigation Action 2S was broadened to investigate various opportunities for beach nourishment and replenishment in concert with rebuilding the City's groin located at the east end of the main beach. Additionally, a new Mitigation Action 2Z was added to investigate long-term options to manage sea level rise and coastal erosion, referencing recommendations as identified by the Surfrider Foundation.

2 Chapter Two – Community Profile

2.1 Physical Setting

Capitola is a small coastal community in Santa Cruz County, encompassing approximately two square miles. The city is located north of the Monterey Bay shoreline, south of Highway 1, east of the City of Santa Cruz, and west of the unincorporated towns of Soquel and Aptos. Exhibit 1: Regional Vicinity Map, depicts Capitola's regional location. Capitola has a temperate Mediterranean climate and distinct landforms influenced by the San Andreas Fault system. Figure 1 is a historic photo of Capitola viewed from the Esplanade.

The City of Capitola is a popular tourist destination due to its beaches, historic charm, visitor amenities, and scenic location. Capitola has a population of approximately 10,000 residents; however, the number of tourists visiting the City on a given day can be more than three times this number.

2.2 History

Capitola has always been a popular tourist and resort area. Between 1874 and 1883, "Camp Capitola" was primarily a campground for families vacationing during the summer season. Capitola's owner, Frederick Augustus Hihn, contracted for construction of the resort's first hotel in 1878. He began to subdivide surrounding tracts for the sale of lots for summer homes in 1882. Two years later, Hihn added an annex to the hotel and built a ballroom/skating rink and other amenities. About that time, the railroad through Capitola was broad gauged. Costing between $100 and $300, the lots began to sell rapidly with the added convenience of the improved rail line. Hihn's improvements continued, including construction of the Grand Hotel Capitola from 1894-1897 and the addition of the Union Traction Company streetcar line in 1903-4.

Figure 1 – The Esplanade (ca. 1910)

When Hihn died in 1913, his Capitola resort properties were inherited by his daughter Katherine Henderson. In 1919, she sold to capitalist H. Allen Rispin and a syndicate of San Francisco investors. By 1920, Rispin owned the entire waterfront, the Capitola Hotel, resort concessions, and 30 acres along Soquel Creek. The decade between 1920 and 1930 saw an increase in construction in Capitola; however, during the Depression many buildings burned, including the hotel.

In 1949, the residents of Capitola were successful in their campaign to incorporate. The new city had a population of 2,000 residents. In the late 1960's and early 1970's, Capitola experienced a growth surge with the construction of the Capitola Mall along 41st Avenue. For several decades, Capitola Mall was the regional shopping destination in the County. New retail options countywide beginning in the 1990's meant less growth for Capitola's primary retail mall area.

Today, Capitola remains a popular tourist destination. Shops and restaurants are located throughout the Village while the beach areas offer a variety of opportunities for recreational activities. Throughout the years since Capitola was first developed a myriad of hazard events have occurred that have impacted the City's residents, businesses, and infrastructure. Appendix A – Timeline of Capitola Natural Hazard Events provides a chronology of the natural hazard events that have affected the City, which includes dates and times (where available), pictures, and background information regarding the event.

2.3 Community Profile

The City of Capitola has a population of approximately 10,000 residents within an area of approximately two square miles. Tables 2 through 4 provide an overview of the City's population data, ethnicity, and education levels.

Table 2: **Capitola Population Data**

Population	
Total Population	10,080
Median Resident Age	41.9
Median Household Income	$ 69,016
Per Capita Income	$ 38,229
Median House Value	$ 585,100
Source U. S. Census American Community Survey, July 2018	

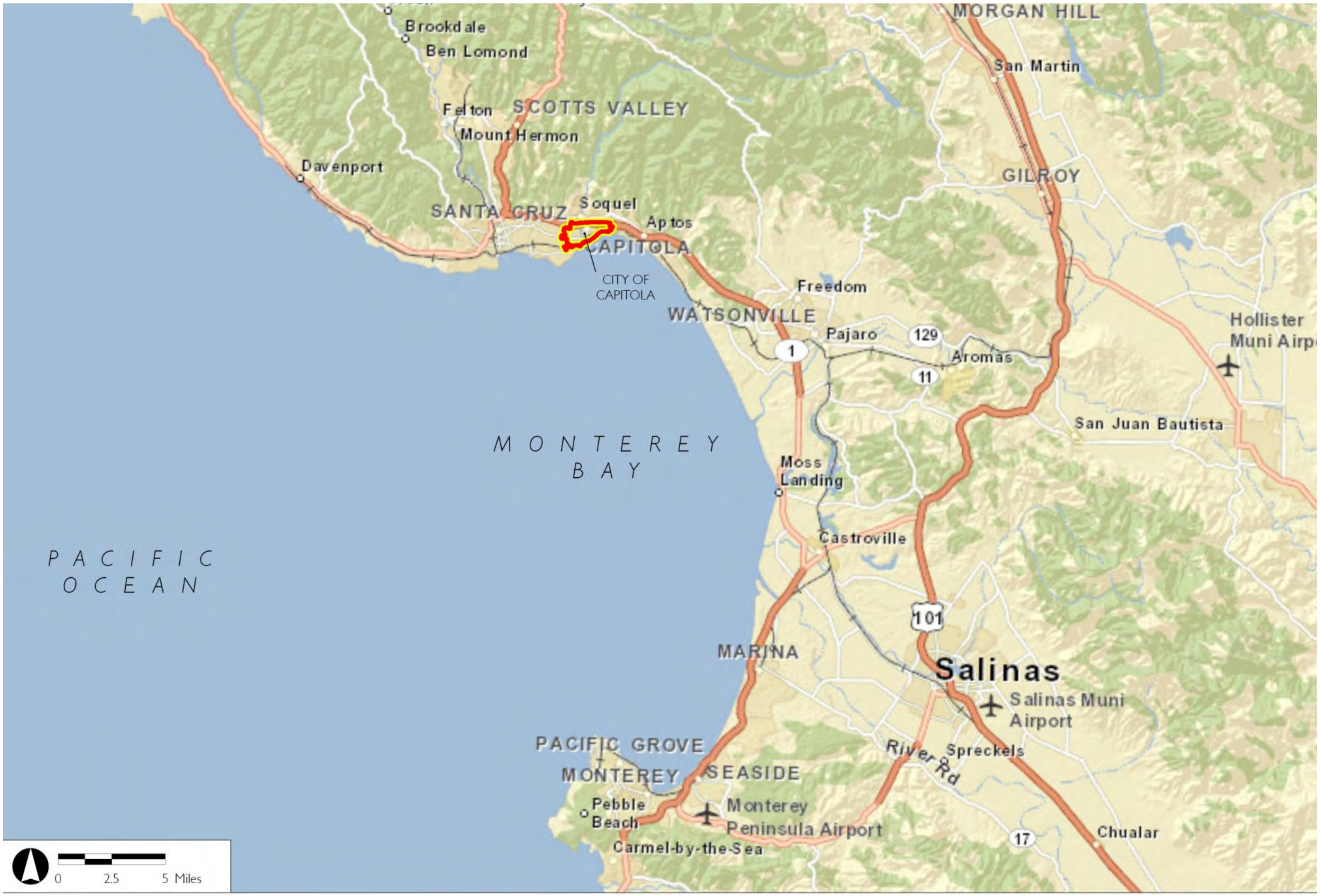
Table 3: **Capitola Ethnicity**

Ethnicity	
White (non-Hispanic)	86.7%
Black	0.5%
American Indian	0.1%
Asian	4.3%
Pacific Islander	0.0%
Two or More Races	5.8%
Hispanic or Latino	26.8%
Source U. S. Census American Community Survey, July 2018	

Table 4: **Capitola Education Levels**

Education Attainment (Age 25 and Over)	
High school graduate or higher	92.7%
Bachelor's degree or higher	36.8%
Source U. S. Census American Community Survey, July 2018	

Exhibit 1: Regional Vicinity Map



2.4 Economic Trends

Capitola City is predominantly occupied by residential uses. The City contains a large retail presence, particularly along 41st Avenue. There is strong demand for visitor accommodations, particularly during the summer months.

Capitola's high rate of workers commuting to jobs outside the City shows that Capitola largely serves as a bedroom community for people working outside the City. However, the City also features more jobs than employed residents, thus indicating a mismatch between the kinds of jobs offered versus the skill levels and occupations of residents.

2.5 Existing Land Use

The General Plan is the principle policy document that regulates land use in Capitola. The Land Use Element contains a Land Use Map (refer to Exhibit 2: Land Use Map), that identifies 12 land use designations. Table 4: General Plan Land Use Designations identifies the General Plan land use designations and description of the typical uses allowed within each designation. The City of Capitola General Plan addresses the use and development of private land, including residential and commercial areas.

Capitola's land use pattern is well established and is unlikely to change in the future. Single-family homes are the most common land use in Capitola, occupying 26 percent of the city. Residential land uses, as a group, occupy more than half of the City area. Retail is the most common commercial land use, occupying 11 percent of the city. A relatively small percentage of Capitola is occupied by office, industrial and mixed uses (1 percent each). A relatively large percentage of the city (14 percent) is occupied by open space and recreational land uses, and approximately 4 percent of City land is vacant.

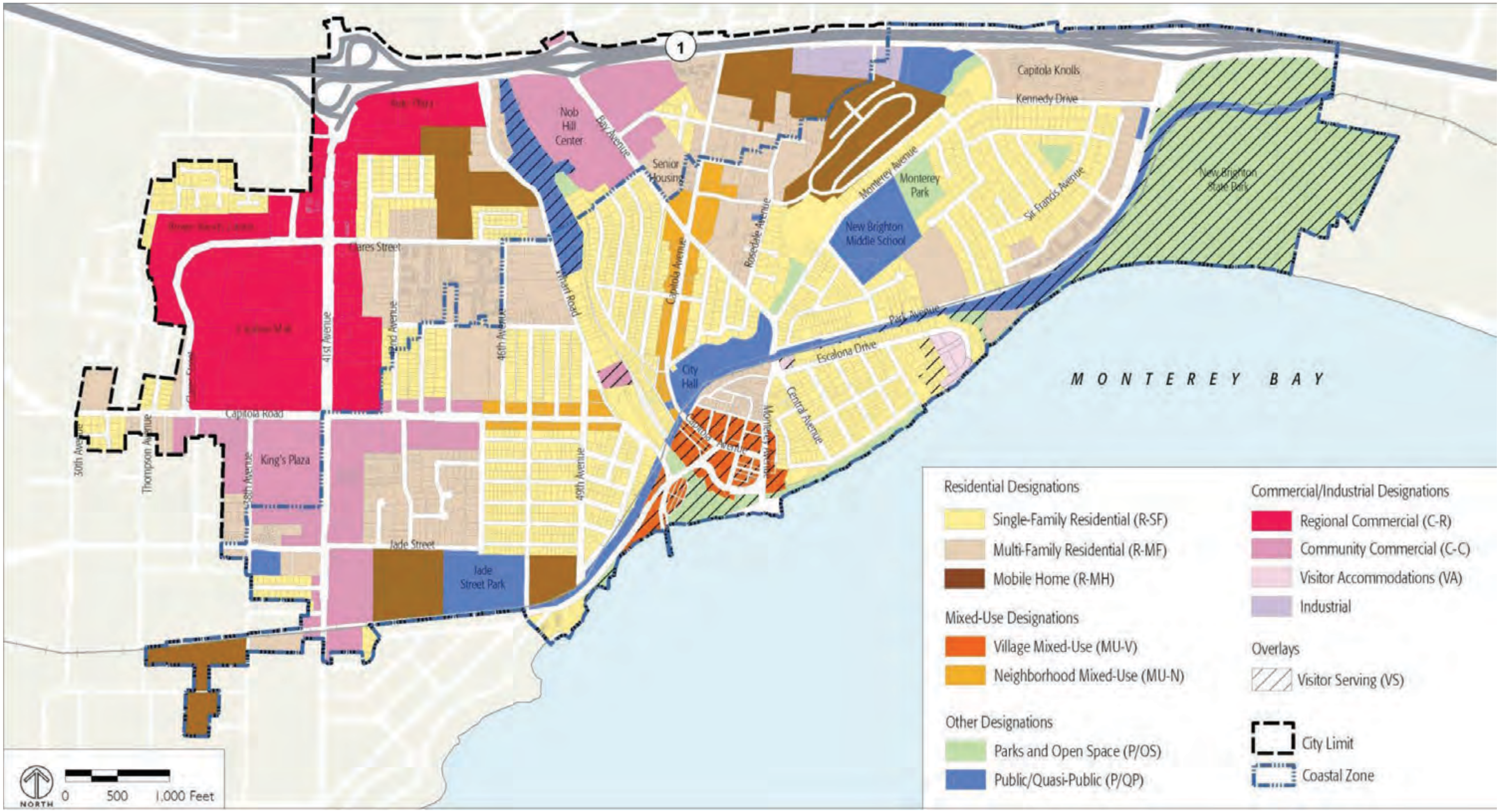
Using these land use designations, the City of Capitola has some capability to reduce risks to lives and property from natural and man-caused hazards. For example, open space land use can be designated in areas of hazard risk to prevent damage to developed property. Similarly, understanding where residential and commercial land uses are in relation to hazard risk is a key component to implementing mitigation strategies.

Table 5: **General Plan Land Use Designations**

	Land Use Designation	Description
RESIDENTIAL	Single-Family Residential (R-1)	Primarily detached single-family homes. Allows residential uses up 10 dwelling units per acre.
	Multi-Family Residential (RM)	Allows residential uses at a density of 5 to 20 units per acre.
	Mobile Home (R-MH)	Allows mobile home development at 20 mobile homes per acre.
COMMERCIAL	Village Mixed-Use (MU-V)	Applies to properties the Capitola Village. Allows for a mix of commercial, residential, visitor-serving, recreational, and public uses.
	Neighborhood Mixed Use (MU-N)	Allows for a mixture of commercial and residential land uses.
	Community Commercial (C-C)	Allows for commercial areas that serve local neighborhoods.
	Regional Shopping (C-R)	Allows for large-scale shopping areas that provide goods and services to the regional population.
	Industrial (I)	Allows for industrial land uses.
VISITOR SERVING		
	Visitor Serving (VS)	Allows for visitor-serving land uses and activities.
OTHER	Parks and Open Space (P/OS)	Applies to open space lands whose primary purpose is recreation.
	Public/Quasi-Public (P/QP)	Applies to areas for public utility facilities.

Source: City of Capitola General Plan, 2019

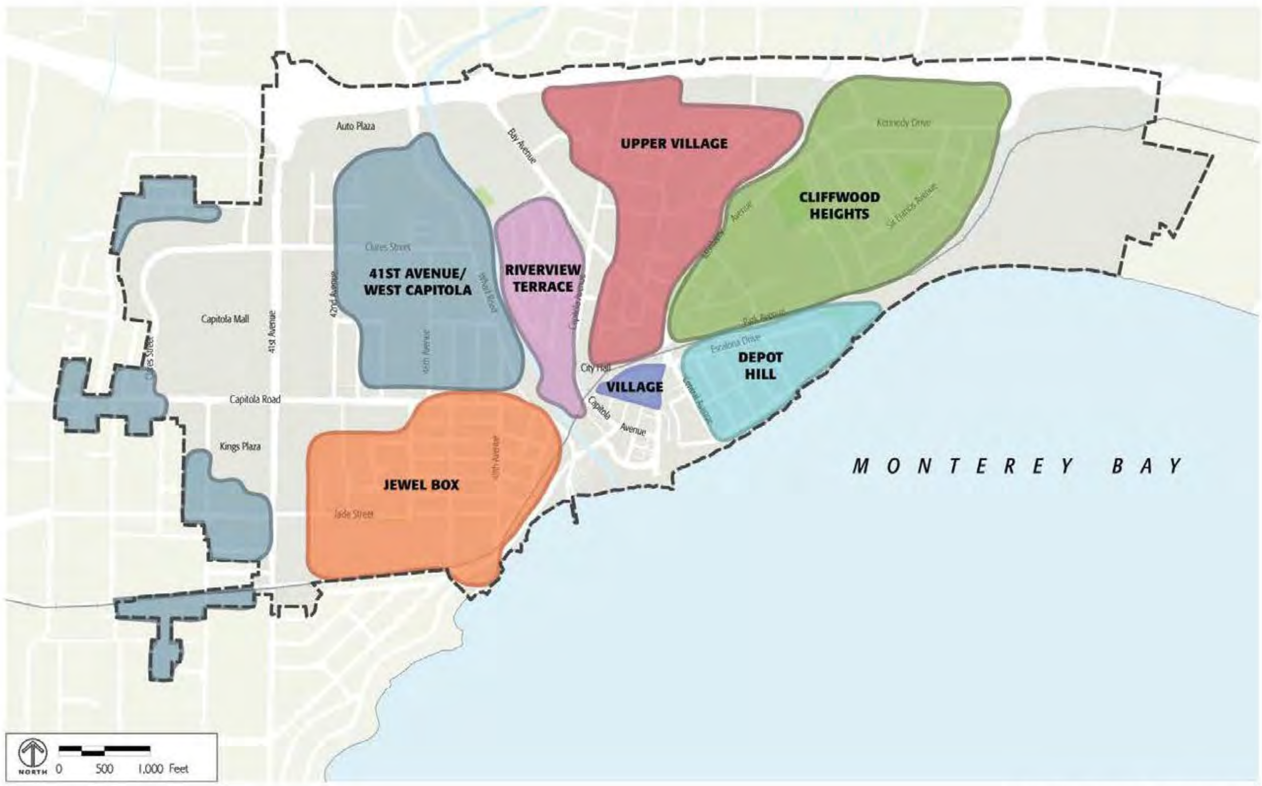
EXHIBIT 2: Land Use Map



2.6 Residential Neighborhoods

Residential uses in Capitola are grouped together in neighborhoods, each with their own special character. The general boundaries of these neighbor-hoods are shown in Exhibit 3 - Capitola Neighborhoods. Each neighborhood has a unique identity defined by its history, design character, land use mix, and natural setting.

EXHIBIT 3: Capitola Neighborhoods



Source: City of Capitola, 2010. *Neighborhood boundaries are approximate.

2.6.1 41st Avenue/West Capitola

The 41st Avenue/ West Capitola neighborhood is comprised of an assortment of detached single-family homes, multi-family housing, and three mobile home parks. The area is known by some as the "North Forties" and includes the Trotter Street area. Housing constructed in the 1970s and 1980s creates a more modern feel to the neighborhood. The Rispin property, the Shadowbrook property, and the Capitola Library are located along the eastern edge of the neighborhood.

2.6.2 Cliffwood Heights

The Cliffwood Heights neighborhood consists primarily of detached single-family homes as well as multi-family housing on Monterey Avenue and Park Avenue. Homes are typically one or two stories occupying relatively large lots. Wider streets with sidewalks and newer homes contribute to a more contemporary feel to the neighborhood. Monterey Park, Cortez Park, and New Brighton Middle School are also located within the Cliffwood Heights neighborhood.

2.6.3 Depot Hill

The Depot Hill neighborhood is nestled along Capitola's shoreline and overlooks Capitola Village. Detached single-family homes on relatively small lots create an intimate feel. A high concentration of historic single-family homes, a variety of architectural styles, and a sidewalk exemption allowance contributes to the neighborhood's coastal village feel. The Inn at Depot Hill and Monarch Cove Inn (formerly El Salto Re-sort) are located in the Depot Hill neighborhood.

2.6.4 Jewel Box

The Jewel Box neighborhood is tucked in the northerly cliff, bounded by the Prospect bluff overlooking the Wharf and Village, located south of Capitola Road and east of 41st Avenue. East of 45th Avenue detached single-family homes occupy quaint lots. Vintage beach cottages and bungalows contribute to a coastal village feel in this community. Multi-family condominiums line the west side of 45th Avenue, with lawns between buildings. The Jewel Box neighborhood includes the West Cliff neighborhood and also contains two mobile home parks, the 10-acre Jade Street Park, Opal Cliffs Elementary School, and the Jade Street Community Center; and a few commercial establishments along Capitola Road.

2.6.5 Riverview Terrace

The Riverview Terrace neighborhood is bordered by Soquel Creek, Capitola Avenue, Bay Avenue, and Center Street. The neighborhood contains a high concentration of historic homes, including many smaller cottages and bungalows. Many homes occupy small lots, with minimal setbacks and structures in close proximity to one another and the street. Narrow streets with on-street parking and no sidewalk contribute to a compact and intimate feel.

2.6.6 Upper Village

The Upper Village neighborhood contains a variety of housing types, including single-family homes, multi-family apartment complexes, and three mobile home parks. In many cases these different land uses are adjacent to or facing one another. Homes located closer to the Village tend to have a more historic and intimate character than those located closer to Highway 1.

2.6.7 Capitola Village

Capitola Village is the "heart" of Capitola and possesses the charm of an inti-mate coastal village. The Village is a true mixed-use district with a diversity of visitor-serving commercial establishments, public amenities, and residential uses. During the summer months, the Village is a popular tourist destination. Visitors are attracted by Capitola Beach, unique accommodations, and the historic village character. Village residents enjoy these amenities year round. The Village is pedestrian friendly, with human-scale architecture and a diversity of public gathering places. Capitola Village contains a high concentration of landmark destinations such as the Esplanade Park, Capitola Beach, the Six Sisters, the Venetian, and the historic Capitola Wharf.

2.7 Development Trends

The City of Capitola is largely built-out, with very little vacant land remaining for new development. The majority of future development in the City is likely to consist of extensive remodeling of existing structures or redevelopment of properties requiring demolition and replacement of existing buildings.

The Capitola City Hall contains the City's administrative departments as well as the Police Department. Across the street is the Central Fire Protection District Station No. 4. Both a portion of City Hall and the fire station are located within the FEMA 100 year flood plain.

Note no changes in development that would result in a decrease or increase in risk to the city…

2.8 Critical Facilities

As shown in Table 5: Capitola Critical Facilities List, there are 25 critical facilities in the City of Capitola. Exhibit 4 – Capitola Critical Facilities identifies their location. These include a police station, fire station, City owned properties, shelters, and other facilities that provide important services to the community. Damage to these facilities during a hazard event has the potential to impair response and recovery from the event and may lead to disruption of critical emergency services. This list includes facilities owned and operated by City or local utilities and districts, but does not include state or federal facilities, which are outside local control.

The LHMP Team identified replacement and contents values for a majority of the facilities. These represent the total potential loss value for each facility. If a facility is destroyed in a hazard event, the replacement and contents values indicate the cost to replace the facility. Typically, the cost to repair a damaged facility will be less than the replacement value. While the replacement and contents values are used throughout this plan to estimate potential losses, it is noted that the actual cost to recover from a hazard event will depend on the type and magnitude of the event.

Table 6: **Capitola Critical Facilities List**

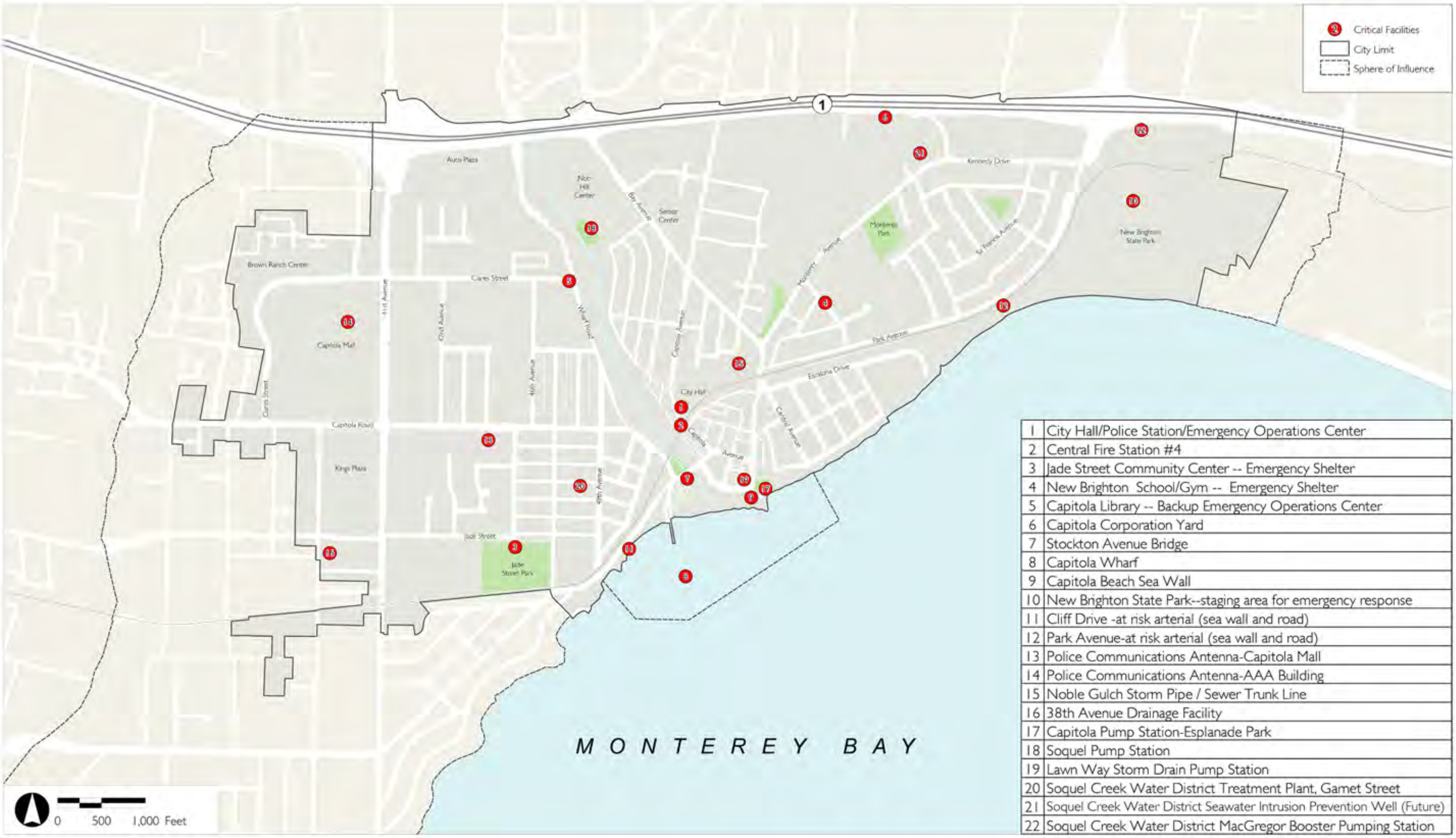
Map #	Facility	Notes	Replacement Value	Contents Value
1	City Hall/Emergency Operations Center	Steep hillside on southern portion of site	$8,000,000	$750,000
1	Capitola Police Station	Steep hillside on southern portion of site	$4,000,000	$750,000
2	Central Fire Station #4	Steep slope across Capitola Road	$3,000,000	$100,000
3	Jade Street Community Center - Emergency Shelter and Police Antenna		$3,000,000	$200,000
4	New Brighton Gym and Performing Arts Center-- Emergency Shelter		$2,500,000	$75,000
4	New Brighton School Performing Arts Center-Back-up Emergency Shelter		$4,000,000	$700,000
5	Capitola Library -- Backup Emergency Operations Center	Wharf Road in vicinity of library located adjacent to steep slope hazard area	$10,000,000	$700,000
6	Capitola Corporation Yard	Creek to the east has steep slopes, no risk	$2,000,000	$500,000
7	Stockton Avenue Bridge	Mid-span piers catch mud and debris	$10,000,000	N/A
8	Capitola Wharf		$20,000,000	$300,000
9	Capitola Beach Sea Wall		$5,000,000	N/A
10	New Brighton State Park - staging area for emergency response		N/A	N/A
11	Cliff Drive - at risk arterial (sea wall and road)		$8,000,000	N/A

Table 6: **Capitola Critical Facilities List**

Map #	Facility	Notes	Replacement Value	Contents Value
12	Park Avenue - at risk arterial (sea wall and road)		$4,000,000	N/A
13	Police Communications Antenna - Capitola Mall		$100,000	N/A
14	Police Communications Antenna-AAA Building		$100,000	N/A
15	Noble Gulch Storm Pipe		$10,000,000	N/A
16	38th Avenue Drainage Facility		$2,000,000	$300,000
17	Capitola Sewage Pump Station - Esplanade Park		$10,000,000	$800,000
18	Soquel Sewage Pump Station		$10,000,000	$1,700,000
19	Lawn Way Storm Drain Pump Station		$500,000	N/A
20	Soquel Creek Water District Treatment Plant, Garnet Street	Costs per SCWD.	$2,000,000	$700,000
21	Soquel Creek Water District Seawater Intrusion Prevention Well, Monterey Avenue	To be constructed as part of the Pure Water Soquel project.	$2,000,000	$70,000
22	Soquel Creek Water District MacGregor Booster Pumping Station		$300,000	N/A
23	Capitola Beach Flume		$2,000,000	N/A
24	Capitola Beach Jetty		$3,000,000	N/A
25	Grand Avenue Cliffs		N/A	N/A
Total Potential Losses			**$125,500,000**	**$7,645,000**

CAPITOLA CRITICAL FACILITIES

EXHIBIT 4



Source: City of Capitola, 2010; Santa Cruz County, 2010.

3 Chapter Three – Hazards Assessment

This chapter provides a detailed discussion of the potential hazards and potential risk/ vulnerability to City facilities.

3.1 Hazard Identification and Prioritization

3.1.1 Hazard Identification

Table 7: City of Capitola Hazard Identification summarizes the natural hazards and shows which were identified in the 2013 LHMP and retained in this update. Hazards that have been excluded from further consideration are shaded gray.

Table 7: **City of Capitola Hazard Identification**

Hazard	Risk	Rationale
Agricultural Pests	No	Not enough agriculture in the City to warrant a concern.
Avalanche	No	Not Applicable
Coastal Erosion / Bluff Failure	Yes	This is an event based concern as well as a long term concern, specifically because storm/sewer utility pipelines run through the bluffs.
Coastal Storm	Yes	Concerns include high surf, high tide, storm related coastal flooding from ocean and fluvial (Soquel Creek), wharf protection
Dam Failure	No	There are no levees or dams that failure would impact the City.
Drought	Yes	The City receives about 90% of its water supply from Soquel Creek Water District (SqCWD) while the remaining 10% is supplied by the City of Santa Cruz Water Department (SCWD). Both agencies are solely dependent upon local water supplies as no water is imported from outside of the area. SqCWD obtains 100% of its supply from groundwater sources, whereas the SCWD is primarily supplied by surface water sources. Both water providers are susceptible to drought and water supply shortages. While groundwater sources are generally less susceptible to seasonal drought than surface water sources, coastal groundwater levels in the area are below elevations that protect the local groundwater basin from seawater intrusion, creating a state of overdraft that is exacerbated by drought conditions.
Earthquake (Liquefaction)	Yes	Capitola is located in an area susceptible to earthquake ground shaking and liquefaction.

Hazard	Risk	Rationale
Expansive soils	No	Discussion during TAC Meeting #1 indicated some concern regarding expansive soils along Soquel Creek and other parts of the City. Mapping conducted after the meeting indicated that expansive soils are identified within the City, however no issues as a result of these soils have been reported.
Extreme Temperature	No	During the 2006 heat wave, the City of Capitola did not experience any problems. Extreme cold in the past has caused a few pipe breaks but no significant problems.
Flood	Yes	Flooding within Capitola occurs as a result of surface water runoff from the mountainous areas north and east of the City, changes in tidal elevations (high tide), local coastal storms, and surges from distant storms offshore. These sources can occur separately or in conjunction with one another increasing the magnitude of the effects.
Geological Hazards	N/A	This category may be used to group bluff erosion, earthquake, landslides, etc. in the hazard profiles.
Hailstorm	No	There has been no significant damage from previous storms. The TAC noted that thunderstorms with lightening could damage antennas used for communication, but agreed it was not a significant risk.
Hazardous Materials Spills	Yes	The majority of properties within the City containing hazardous materials are located along 41st Avenue. Additional concerns include Highway 1, railroad, oil spills, and the drinking water treatment facility in the Jewel Box area.
Hurricane	No	Not Applicable
Land Subsidence	No	Not Applicable
Landslide and Mudflow	Yes	Due to steep topography, there is a potential for landslides and mudflows to occur below Wharf Road and above Soquel Creek, which could impact the Stockton Avenue Bridge and Village.
Human Caused Hazards	No	Except for Hazardous Materials Spills, the TAC agreed the intent of this plan is to focus on natural hazard risk.
Severe Winter Storm	No	Not Applicable
Tornado	No	Tornados and water spouts are possible, but very rare. The TAC noted that a tornado occurrence could be devastating, but the probability does not warrant inclusion in this plan.
Tsunami	Yes	Due to its location along the coast, Capitola is susceptible to Tsunami inundation, which could reach as high as 30 feet depending on the location of the source. Evacuations within the City occurred as a result of the most recent tsunami event in March 2011; however, no damage occurred within the City.
Volcano	No	The City is not located within a region of active volcanism.

Hazard	Risk	Rationale
Wildfire	Yes	Concerns include: Wharf Road Corridor, New Brighton area, eucalyptus trees along the bluffs
Wind	No	Regular wind does not cause significant damage
Windstorm	Yes	During severe windstorms trees fall. Severe wind also exacerbates wildfires.
Sea Level Rise	Yes	The City is located adjacent to the Pacific Ocean and is therefore prone to the effects of seal level rise. To address this issue, the City recently participated in a sea level rise study and its potential impacts in and around Capitola, which is included as Appendix C.
Climate Change	N/A	Climate change will be considered as an exacerbation factor for all of the identified hazards.

3.1.2 Hazard Prioritization

City staff and their consultant involved in preparing the 2020 LHMP update assigned each hazard a ranking based on probability of occurrence and potential impact. These rankings were based on group discussion, knowledge of past occurrences, and familiarity with the City's infrastructure vulnerabilities. The results are presented in Table 8: Capitola Hazard Ranking Worksheet.

Table 9: Capitola Hazard Ranking Worksheet Legend provides additional detail regarding how the probability, affected area, and impact categories were weighted and how the total score was calculated.

Table 8: **Capitola Hazard Ranking Worksheet**

Hazard Type	Probability	Impact			Total Score	Hazard Planning Consideration
		Affected Area	Primary Impact	Secondary Impacts		
Earthquake (and Liquefaction)	4	4	4	4	64.00	Significant
Flood (riverine and coastal, including storm surge)	4	4	4	4	64.00	Significant
Sea Level Rise	4	1	4	4	44.80	Significant
Drought	3	4	3	3	40.80	Moderate
Windstorm	3	4	3	2	37.80	Moderate
Coastal Erosion / Bluff Failure	4	1	3	2	31.20	Moderate
Tsunami	2	2	4	4	25.60	Moderate
Hazardous Materials	2	3	3	3	24.00	Moderate
Wildfire	2	2	2	2	16.00	Moderate
Landslide and Mudflow	2	1	2	2	12.80	Moderate
Expansive soils	1	2	2	2	8.00	Limited

Table 9: **Capitola Hazard Ranking Worksheet Legend**

Probability	Importance	2.0
Based on estimated likelihood of occurrence from historical data		
Probability		Score
Unlikely (Less than 1% probability in next 100 years or has a recurrence interval of greater than every 100 years.)		1
Somewhat Likely (Between 1 and 10% probability in next year or has a recurrence interval of 11 to 100 years.)		2
Likely (Between 10 and 100% probability in next year or has a recurrence interval of 10 years or less.)		3
Highly Likely (Near 100% probability in next year or happens every year.)		4
Affected Area	Importance	0.8
Based on size of geographical area of community affected by hazard		
Affected Area		Score
Isolated		1
Small		2
Medium		3
Large		4

Secondary Impacts	Importance	0.5
Based on estimated secondary impacts to community at large		
Impact		Score
Negligible - no loss of function, downtime, and/or evacuations		1
Limited - minimal loss of function, downtime, and/or evacuations		2
Moderate - some loss of function, downtime, and/or evacuations		3
High - major loss of function, downtime, and/or evacuations		4
Total Score = Probability x Impact, where:		
Probability = (Probability Score x Importance)		
Impact = (Affected Area + Primary Impact + Secondary Impacts), where:		
Affected Area = Affected Area Score x Importance		
Primary Impact = Primary Impact Score x Importance		
Secondary Impacts = Secondary Impacts Score x Importance		

Table 9: **Capitola Hazard Ranking Worksheet Legend**

Primary Impact	Importance	0.7		Hazard Planning Consideration			
Based on percentage of damage to typical facility in community				Total Score	(Range)	Distribution	Hazard Level
Impact		Score		0.0	12.0	1	Limited
Negligible - less than 10% damage		1		12.1	42.0	7	Moderate
Limited - between 10% and 25% damage		2		42.1	64.0	3	Significant
Critical - between 25% and 50% damage		3					
Catastrophic - more than 50% damage		4					
The probability of each hazard is determined by assigning a level, from unlikely to highly likely, based on the likelihood of occurrence from historical data. The total impact value includes the affected area, primary impact and secondary impact levels of each hazard. Each level's score is reflected in the matrix. The total score for each hazard is the probability score multiplied by its importance factor times the sum of the impact level scores multiplied by their importance factors. Based on this total score, the hazards are separated into three categories based on the hazard level they pose to the communities: Significant, Moderate, and Limited.							

Based on this ranking exercise, the City of Capitola confirmed the identified hazards and corresponding planning considerations for this 2020 LHMP update as those listed in Table 10: Capitola Identified Hazards and Planning Considerations.

Table 10: **Capitola Identified Hazards and Planning Considerations**

Identified Hazard	Hazard Planning Consideration
Earthquake (and Liquefaction)	Significant
Coastal Storm / Flooding	Significant
Sea Level Rise	Significant
Drought	Moderate
Windstorm	Moderate
Coastal Erosion / Bluff Failure	Moderate
Tsunami	Moderate
Hazardous Materials	Moderate
Wildfire	Moderate
Landslide and Mudflow	Moderate

3.2 Climate Change Considerations

It should be noted that sea level rise was originally identified as an explicit hazard by the Technical Advisory Committee, however through follow up discussion with the HMP Team, it was determined that sea level rise is an effect associated with climate change. Since climate change also can affect other hazards within the City, the HMP Team determined that it would be best to discuss climate change considerations throughout all applicable hazard profiles.

In June of 2017, the Central Coast Wetlands Group published the City of Capitola Coastal Climate Change Vulnerability Report. This report is incorporated into this 2020 LHMP update by reference and is included as Appendix C. The evaluation provides a predictive chronology of future risks to assist with local coastal planning and foster discussions with state regulatory and funding agencies.

Climate change is a serious issue, as it affects communities in a variety of ways. For the City of Capitola, climate change can result in a multitude of impacts and potentially exacerbate existing natural and human caused hazards or create new hazards. To address potential climate change impacts, the City of Capitola has identified climate change considerations within each hazard profile in this Plan. These considerations deal with issues such as sea level rise, changing weather patterns and precipitation regimes, coastal storms, flooding, and other hazards that could be exacerbated by these changing conditions. Within each hazard profile, the City has provided a discussion of some of the potential impacts that could be a result of climate change. This discussion is intended to supplement, but not replace, the Probability of Future Occurrence discussion.

3.3 Vulnerability/Risk Assessment Methodology[1]

The critical facilities listed in the section above were mapped in GIS and overlaid with mapped hazard areas to determine which assets are located within each hazard area. Hazard area and critical facility overlays were

[1] All GIS data used in the vulnerability analyses profiled in Section 3.3 was provided by the City of Capitola, County of Santa Cruz or applicable State or Federal Agency.

conducted for flood, beach erosion, cliff erosion, liquefaction, landslide/mudslide (slope), and tsunami. For hazardous materials, it was determined which critical assets are located within 500 and 1,000 feet of a hazardous materials site.

Hazard and critical facility overlays were not conducted for wildfire, windstorm, drought, and earthquake. Per Santa Cruz County fire hazard maps, there are no fire hazard areas located in the City of Capitola. Windstorms affect the entire City and therefore all facilities listed in the critical facility inventory could be potentially susceptible to damage from a windstorm. Drought does not inflict physical damage on Capitola's critical assets; however, residents could be impacted by potential restrictions from the two water districts. 90% of the City's water supply is provided by the Soquel Creek Water District, which, although supplied by groundwater and less susceptible to seasonal drought, is susceptible to overdraft. The remaining 10% of the water supply is provided by the City of Santa Cruz Water Department, which is supplied by surface water and is susceptible to seasonal drought. There are no fault zones that fall within the City of Capitola and therefore an overlay was not conducted for earthquake.

Each hazard profile in the section below includes a Vulnerability/Risk Assessment section that presents the results of the methodology described above. Replacement and contents values for the facilities that fall within the hazard areas are tallied in each vulnerability table to estimate the total potential losses to each hazard. It should be noted that the actual losses will depend on the type and extent of the hazard event.

Combined coastal climate change hazards were based on findings as described in the City of Capitola Coastal Change Vulnerability Report, June 2017, which is incorporated in this LHMP update and included as Appendix C.

A comprehensive list of facilities and the hazard areas they fall within can be found in Appendix A – Critical Facilities Inventory.

3.4 Hazard Profiles

The following are profiles of the hazards identified for the City of Capitola. The profiles include a vulnerability analysis and risk assessment using the methodologies described in the Vulnerability/ Risk Assessment Section above.

3.4.1 Geologic Hazards (Earthquake and Liquefaction)

Identifying Earthquake and Liquefaction Hazards

An earthquake is a sudden release of energy in the earth's crust. Caused by movement along fault lines, earthquakes vary in size and severity. The focus of an earthquake is found at the first point of movement along the fault line (which may be beneath the surface), and the epicenter is the corresponding point above the focus at the earth's surface.

Damage from an earthquake varies with the local geological conditions, the quality of construction, the energy released by the earthquake, the distance from the earthquake's focus, and the type of faulting that generates the earthquake. Earthquake related hazards include primary impacts (fault rupture and ground shaking) and secondary impacts (liquefaction). This hazard profile will discuss ground shaking and liquefaction, since these are the two most likely impacts anticipated as a result of an earthquake.

Ground Shaking: Ground motion/shaking is the primary cause of damage and injury during earthquakes and can result in surface rupture, liquefaction, landslides, lateral spreading, differential settlement, tsunamis, building and infrastructure failure, which could lead to fire and other collateral damage. Typically, areas underlain by thick, water-saturated, unconsolidated material will experience greater shaking motion than areas underlain by firm bedrock, but, in some cases, topographic relief may intensify shaking along ridge tops, where landslides may develop.

Fires and structural failure are the most hazardous results of ground shaking. Most earthquake-induced fires start because of ruptured power lines and gas lines or electrically powered stoves and equipment. Structural failure is generally a result of age, quality, and type of building construction.

Liquefaction: Liquefaction is the transformation of loose, water-saturated granular materials (such as sand and silt) from a solid to a liquid state. This results in the loss of soil strength and the soil's ability to support weight. Buildings and their occupants are at risk when the ground can no longer support these buildings and structures.

Profiling Earthquake and Liquefaction Hazards

Location

Capitola is located in one of the most seismically active areas of the country. Significant earthquakes occur along well-defined, active fault zones that trend northwesterly. The regional faults of significance potentially affecting Capitola include the San Andreas, the Zayante, and the Palo Colorado-San Gregorio faults. The most probable seismic hazards to Capitola are from the San Andreas Fault (in the Santa Cruz Mountains) and, further south, the Palo Colorado-San Gregorio fault as shown in Exhibit 5 - Active Fault Zones.

The main trace of the San Andreas Fault is approximately nine miles northeast of Capitola. One of the largest local earthquakes in recent history occurred on October 17, 1989 due to movement on this fault (Loma Prieta Earthquake) and measured 7.1 on the Richter scale.

The Zayante fault is located approximately five miles northeast of Capitola, and the Palo Colorado-San Gregorio is located 14 miles southwest of Capitola. The California Geologic Survey considers the Zayante fault active, although it has not caused any significant earthquakes historically, only some aftershocks after the Loma Prieta earthquake. The Palo Colorado-San Gregorio fault is not well understood, but is considered potentially active with an estimated maximum credible magnitude of 7.7 and a recurrence level of 800+ years (City of Capitola General Plan White Paper #4 Environmental Resources & Hazards, 2011).

Liquefaction can also occur in Capitola. Exhibit 6: Liquefaction Potential shows the liquefaction potential in Capitola. Significant portions of Capitola have either High or Very High potential for liquefaction. These areas are generally located along the alignment of drainage courses like Soquel Creek, Noble Gulch and Tannery Gulch. More specifically, areas determined to have a Very High potential include the northern end of Bay Avenue, including Highway 1/Bay Avenue/Porter Avenue interchange, and a large portion of Capitola Village. Areas determined to have a High potential include the residential and commercial areas along the southern portion of Bay Avenue and along Capitola Avenue.

Extent of Earthquake

The size and magnitude (M) of an earthquake is measured in various ways. The Richter scale determines the amount of ground displacement or shaking that occurs near the epicenter. This scale is shown in Table 11: Richter Scale.

Another scale, the Moment Magnitude scale, measures the magnitude of medium and large sized earthquakes by characterizing the amount of energy released by the earthquake. The magnitude is based on the seismic moment of the earthquake, which is equal to the rigidity of the Earth multiplied by the average amount of slip on the fault and the size of the area that slipped. (USGS, Glossary of Terms on Earthquake Maps) The Modified Mercalli Intensity Scale measures ground shaking intensity in terms of perception and damage and takes into account localized earthquake effects. This scale is shown in Table 12: Modified Mercalli Intensity Scale for Earthquakes.

Table 11: **Richter Scale**

Richter Magnitudes (M)	Earthquake Effects
Less than 3.5	Generally not felt, but recorded.
3.5-5.4	Often felt, but rarely causes damage.
Under 6.0	At most slight damage to well-designed buildings. Can cause major damage to poorly constructed buildings over small regions.
6.1-6.9	Can be destructive in areas up to about 100 kilometers across where people live.
7.0-7.9	Major earthquake. Can cause serious damage over larger areas.
8 or greater	Great earthquake. Can cause serious damage in areas several hundred kilometers across.

Table 12: **Modified Mercalli Intensity Scale for Earthquakes**

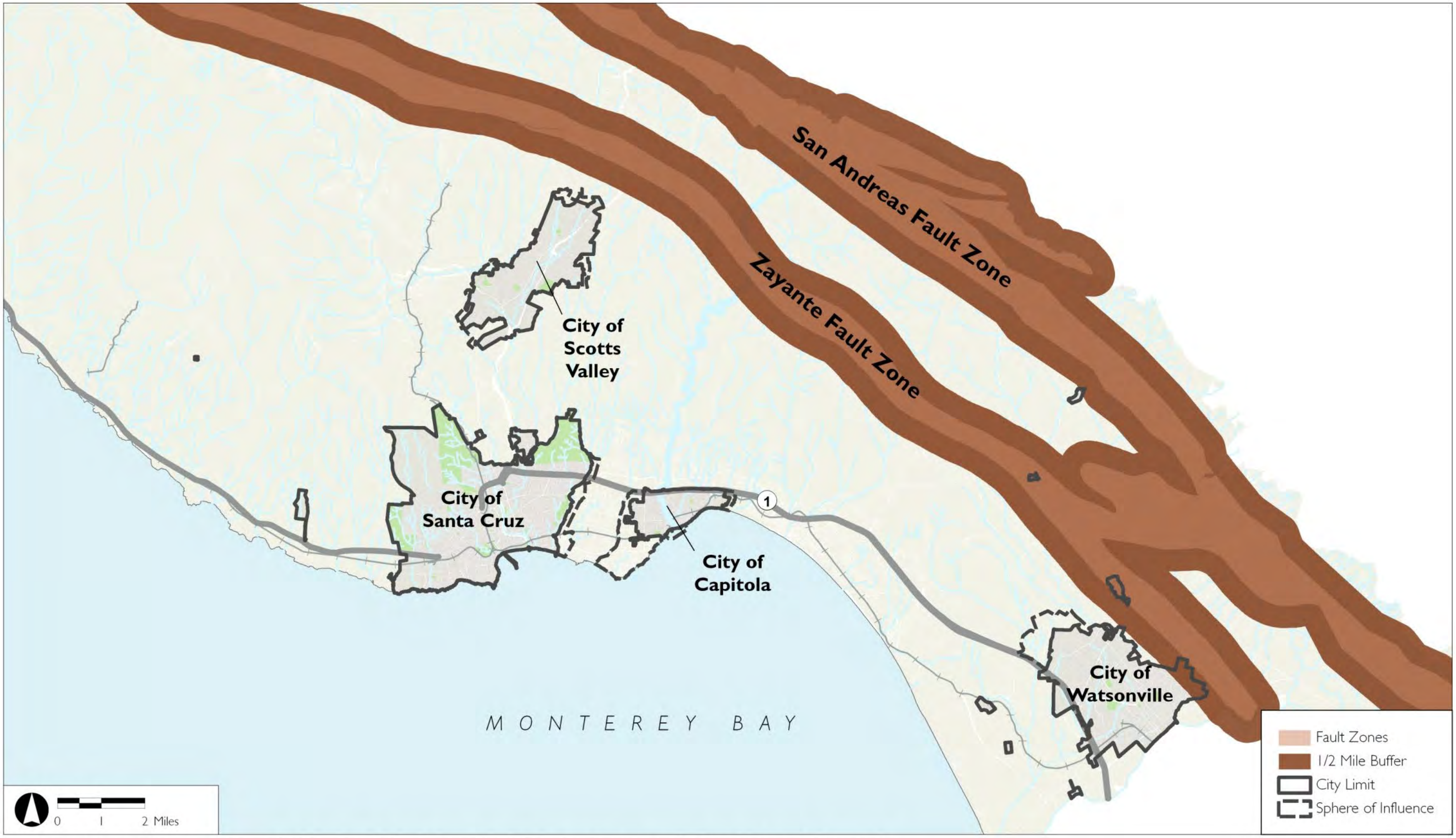
Scale	Intensity	Earthquake Effects	Corresponding Richter Scale Magnitude
I	Instrumental	Detected only on seismographs	
II	Feeble	Some people feel it	<4.2
III	Slight	Felt by people resting; like a truck rumbling by	
IV	Moderate	Felt by people walking	
V	Slightly Strong	Sleepers awake; church bells ring	<4.8
VI	Strong	Trees sway; suspended objects swing; objects fall off shelves	<5.4
VII	Very Strong	Mild Alarm; walls crack; plaster falls	<6.1
VIII	Destructive	Moving cars uncontrollable; masonry fractures; poorly constructed buildings damaged	

Table 12: **Modified Mercalli Intensity Scale for Earthquakes**

Scale	Intensity	Earthquake Effects	Corresponding Richter Scale Magnitude
IX	Ruinous	Some houses collapse; ground cracks; pipes break open	<6.9
X	Disastrous	Ground cracks profusely; many buildings destroyed; liquefaction and landslides widespread	<7.3
XI	Very Disastrous	Most buildings and bridges collapse; roads, railways, pipes and cables destroyed; general triggering of other hazards	<8.1
XII	Catastrophic	Total destruction; trees fall; ground rises and falls in waves	>8.1

Seismic historical records of Capitola show that earthquakes of 6.5 – 7.0 M occur periodically on the San Andreas Fault (City of Capitola General Plan White Paper #4 Environmental Resources & Hazards, 2011). The San Andreas Fault zone poses the most significant threat to Santa Cruz County and to the City of Capitola. Based on records from the 1906 San Francisco earthquake, it is estimated that the maximum credible earthquake likely to occur on the San Andreas Fault would equal 8.3 M on the Richter scale, which represents more than 30 times the energy released by the 1989 Loma Prieta Earthquake. Santa Cruz County was one of the hardest hit counties during that earthquake.

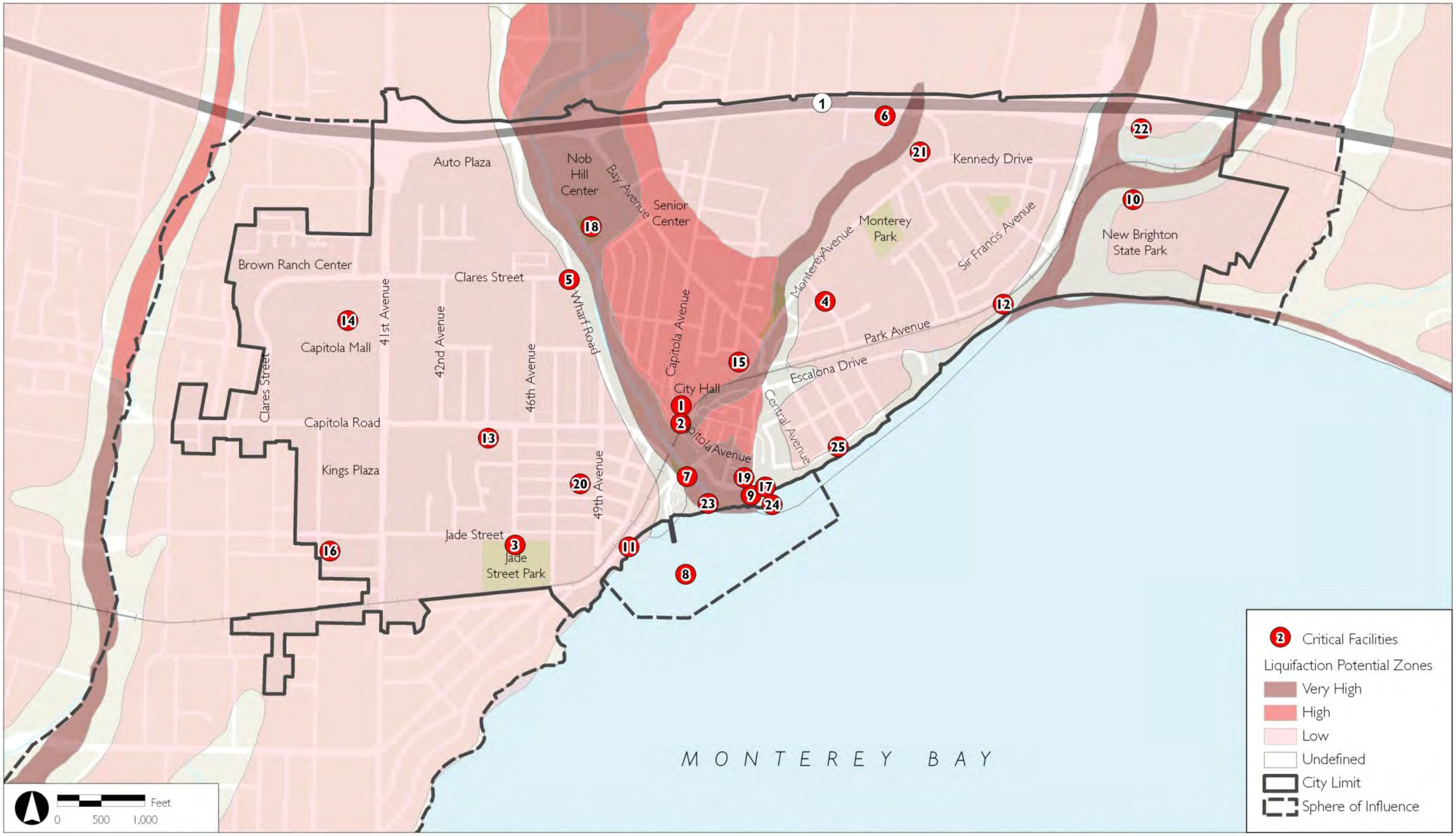
ACTIVE FAULT ZONES
EXHIBIT 5



Source: City of Capitola, 2010; Santa Cruz County, 2010; Hazards. "Fault Zones." [shapefile]. (2012). Santa Cruz County Geographic Information System File Download Site. Available at <http://sccftpmap.co.santa-cruz.ca.us/File%20Download%20Site/Hazards/Shapefiles/Hazards.zip>, Downloaded: February 1, 2012.

LIQUEFACTION POTENTIAL

EXHIBIT 6



Source: City of Capitola, 2010; Santa Cruz County, 2010; Hazards. "Liquifaction." [shapefile]. (2009) Available at <http://sccftpmap.co.santa-cruz.ca.us/File%20Download%20Site/Hazards/Shapefiles/Hazards.zip>, Downloaded: January 29, 2011.

Extent of Liquefaction

Areas within Capitola that have a High and Very High potential for liquefaction (as identified on Exhibit 6) would be the primary areas affected by liquefaction during an earthquake event. In addition, other areas within the City that experience shallow groundwater conditions (less than 50 feet beneath the ground surface [bgs]) may also be susceptible to liquefaction if loose unconsolidated materials are located beneath the surface within these areas.

Past Occurrences - Earthquake

While Santa Cruz County has sustained numerous earthquakes throughout history, the two most destructive incidents were the 1906 San Francisco earthquake and the 1989 Loma Prieta earthquake. Table 13 Historical Earthquake Events summarizes historical records collected by the City of Capitola Historical Museum.

Table 13: **Historical Earthquake Events**

Date	Time	Impact/Property Damage
January 9, 1857		Three earthquakes struck the Santa Cruz vicinity in a series. The tower and a portion of the Santa Cruz Mission Church collapsed.
August 1, 1863		Described as "severe shock"
October 8, 1865		Unknown
October 25, 1868		"Second only to October 1865"
July 1, 1882		Worst since 1868
March 1883		Severe shock with several aftershocks recorded. No damaged listed for Capitola.
September 18, 1888		Described as extremely severe.
1906	5:12am	Nine men killed in mudslide at the Loma Prieta mill above Soquel; surge on local creeks; water pipes broken; chimneys and walls cracked. Splits in the earth. Magnitude 8.3.
October 28, 1926		Damage recorded in Capitola
April 15, 1941		Santa Cruz epicenter. No damage.
June 2, 1941		Sharp jolt
April 15, 1954		Falling plaster, broken chimneys, shattered dishes
January 16, 1980		Epicenter of 3.6 magnitude quake in Corralitos
October 17, 1989	5:04pm, Duration: 15 seconds	6.9 magnitude earthquake, epicenter 3 miles north of Aptos. Comparatively, damage to Capitola homes and businesses was not severe. Within the city, no buildings immediately collapsed and no one was injured physically. Damage countywide ultimately estimated to be about $1 billion.

The events described below were all recorded by a seismic recorder at the Capitola Fire Station.

San Francisco Earthquake: April 18, 1906 - Magnitude 8.3, Intensity Viii-Xiii, occurred 91.1 miles away from City center – The earthquake was felt from southern Oregon to south of Los Angeles and inland as far as central Nevada. There were no recorded deaths in Santa Cruz but the old courthouse partially collapsed and approximately 1/3 of the chimneys within the city of Santa Cruz were destroyed or damaged. Landslides were observed throughout the Santa Cruz Mountains, and fault rupture was nearly continuous along the San Andreas

Fault zone, and nearby fault zones in the county of Santa Cruz. Infrastructure was destroyed and broken water mains and pipes shut off water supply in many areas.

Monterey Bay Earthquake: October 1926 - Magnitude 6.1 – Two large earthquakes caused considerable damage in the Monterey Bay region. The first shock was severe at Santa Cruz, where many chimneys were knocked down, and old brick buildings sustained damage.

Coyote Lake Earthquake: August 6, 1979 - Magnitude 5.9, Intensity VI-VII, occurred 20.7 miles away from City center – Felt from approximately 37 miles north of Bakersfield, north to Sacramento, east to the Pacific Ocean.

Livermore Earthquake: January 24, 1980 - Magnitude 5.9, occurred 52.5 miles from City center – The earthquake injured 44 people and caused an estimated $11.5 million in property damage. The shock was associated with surface rupture along the Greenville fault. It was felt over a large area of central California and a few towns in western Nevada.

Morgan Hill Earthquake: April 24, 1984 - Magnitude 6.2, Intensity VII-IX, occurred 26.5 miles from City center – Damage from the earthquake estimated at 7.5 million dollars. The earthquake was felt from Bakersfield to Sacramento and from San Francisco to Reno.

Unnamed Earthquake: June 27, 1988: Magnitude 5.9, occurred 11.4 miles from City center

Loma Prieta Earthquake: October 17, 1989 - Magnitude 7.1 occurred 5 miles from City Center (see Figure 2) – This major earthquake caused 63 deaths, 3,757 injuries, and an estimated $6 billion in property damage statewide. It was the largest earthquake to occur on the San Andreas Fault since the San Francisco earthquake in April 1906. Communities sustaining heavy damage in the epicentral area included Los Gatos, Santa Cruz, and Watsonville. Liquefaction occurred as far as 110 kilometers from the epicenter and contributed to significant property damage in the Santa Cruz and Monterey Bay area. The severe shaking near Santa Cruz caused heavy damage to the unreinforced masonry buildings in that area. Most of the landslides and rockfalls that occurred as a result of the earthquake occurred in the Santa Cruz Mountains. Shaking from this earthquake was felt throughout Capitola and resulting damage varied from minor structural damage and window and chimney breakage throughout the city. The most extensive damage in the city occurred in mobile home parks where coaches were knocked off their foundations disrupting gas and water services. Figure 3 shows what the City of

Figure 2 - Loma Prieta Earthquake

Capitola looked like just minutes after the earthquake occurred. As seen in the photo a significant amount of dust was generated as a result of the shaking.

Figure 3 - Dust Generated from the Loma Prieta Earthquake (ca. 1989)

San Juan Bautista Earthquake: August 12, 1998 – Magnitude 5.0 – Earthquake occurred on the San Andreas Fault, 12 kilometers southeast of San Juan Bautista.

Gilroy Earthquake: May 13, 2002 – Magnitude 4.9

Parkfield Earthquake: September 28, 2004 – Magnitude 6.0 – Earthquake occurred on the San Andreas Fault. It ruptured roughly the same segment of the fault that broke in 1966. Strong shaking lasted for about 10 seconds.

Alum Rock Area Earthquake: October 30, 2007 – Magnitude 5.6. This was the last significant earthquake before 2020 to occur

Past Occurrences - Liquefaction

Prior instances of liquefaction have not occurred or have been extremely isolated within the City of Capitola.

Probability of Future Occurrence

There are at least six major faults and fault systems within or near Santa Cruz County and the City of Capitola, placing both locations in an area of high seismic risk. Earthquakes can cause severe damage over a long distance and, therefore, Santa Cruz County and Capitola remain at risk from seismic activity along the faults in the greater San Francisco Bay area. The reduction of seismic stresses that occurred in the Loma Prieta earthquake did nothing to relieve, and possibly increased, stresses along other faults, including other sections of the San Andreas Fault.

To clarify the extent of future earthquake risk, a partnership between the United States Geological Survey, California Geologic Survey, and Southern California Earthquake Center was formed in September 2004 to provide a uniform forecast. Known as the Working Group on California Earthquake Probabilities, this group evaluated and systemized currently available historic and paleoseismic information to produce a probabilistic seismic hazards analysis to indicate the type of future earthquakes. One product of this analysis is a method of estimating the probability of ground shaking, which is illustrated in Table 14: Ten Most Likely Damaging Earthquake Scenarios. The 30-year probability of an M ≥ 6.7 earthquake on the northern segment of the San Andreas Fault is 21% and on the San Gregorio Fault is 6%. Other faults within the region can also cause damage in the county, including the Hayward-Rogers Creek Fault that has a 31% probability of having a M ≥ 6.7 earthquake in the next thirty years.

Because the ten most likely future earthquakes in the Bay area occur on faults throughout the region, the impact and potential losses reported here reveal significant risk for the entire San Francisco Bay area region including Santa Cruz County and the City of Capitola.

The probability that liquefaction will occur in the future in Capitola is dependent on many factors including the intensity of ground shaking, location of the earthquake, and subsurface conditions (including groundwater elevation). For those areas of the City identified with a High and Very High liquefaction potential, it should be anticipated that potential damage could occur under anticipated future earthquakes.

Table 14: **Ten Most Likely Damaging Earthquake Scenarios**

Earthquake Fault	30-year probability	Magnitude
Rodgers Creek	15.2%	7.0
Northern Calaveras	12.4%	6.8
Southern Hayward (possible repeat of 1868 EQ)	11.3%	6.7
Northern + Southern Hayward	8.5%	6.9
Mt. Diablo	7.5%	6.7
Green Valley –Concord	6.0%	6.7
San Andreas: Entire N. CA Segment (possible repeat of 1906 EQ)	4.7%	7.9
San Andreas: Peninsula Segment (possible repeat of 1838 EQ)	4.4%	7.2
Northern San Gregorio segment	3.9%	7.2
San Andreas: Peninsula + Santa Cruz segment	3.5%	7.4

Climate Change Considerations

As climate change occurs, it is anticipated that changes to precipitation regimes and hydrological patterns would result. Since liquefaction is dependent on the presence of shallow subsurface water, an increase in groundwater levels could occur due to increased precipitation, as well as sea-level rise, which is anticipated to inundate low lying coastal areas within Capitola. The potential increase in shallow subsurface water conditions could expand the potential liquefiable areas within the City, increasing the risk of future damage to structures within the City.

Vulnerability/Risk Assessment

While Capitola remains a seismically active area, there are no active earthquake faults located within the City limits. Therefore, an overlay analysis between the earthquake faults and the City's critical facilities was not conducted. However, given the proximity to active faults, it is anticipated that a seismic event will produce intense shaking that could impact the entire community's population and systems. Depending on the intensity of shaking and location of the earthquake epicenter, buildings, structures, roadways, and utility systems (i.e. water lines, sewer lines, power lines, and storm drains) could be damaged. It is difficult to identify specific areas within the City that may be more vulnerable than others as a result of this impact. Based on this, it is assumed that all areas are equally vulnerable as a result of seismic impact.

Based on the extent of liquefaction potential zones within the City (Exhibit 6) and the location of critical facilities (depicted on Exhibit 6), Table 15: Capitola Critical Facilities Located in a Liquefaction Potential Zone identifies the critical facilities that fall within each zone of liquefaction potential, ranging from low to very high and the financial implications of their loss. Those areas where liquefaction potential is unknown is determined to be "Undefined".

It is expected that a liquefaction event would most likely impact facilities within the "Very High" potential zone. If all of the facilities in that zone are completely destroyed the loss would amount to $27,500,000. A liquefaction event impacting facilities in the "High" potential zone could result in a total loss of $22,000,000. While it is unlikely that an event would impact facilities in the low liquefaction potential zones and the undefined liquefaction areas, a rare, large, catastrophic event could impact facilities within all liquefaction zones. The total potential losses for an event of this scale are estimated to be a total of $125,500,000.

The extent of the liquefaction potential layer did not allow for the intersection of the Capitola Wharf location. However, given the proximity to water and similar characteristics to other areas of high liquefaction potential within the City, it is assumed that liquefaction could occur in the vicinity of this location.

Table 15: **Capitola Critical Facilities Located in a Liquefaction Potential Zone**

Map #	Facility	Very High (A)	High (B)	Low (D)	Undefined (Unkn)	Replacement Value	Contents Value	Potential Loss
1	City Hall/Emergency Operations Center		X			$8,000,000	$750,000	$8,750,000
1	Capitola Police Station		X			$4,000,000	$750,000	$4,750,000
2	Central Fire Station #4		X			$3,000,000	$100,000	$3,100,000
3	Jade Street Community Center -- Emergency Shelter			X		$3,000,000	$200,000	$3,200,000
4	New Brighton Gym -- Emergency Shelter			X		$2,500,000	$75,000	$2,575,000
4	New Brighton School -- Back-up Emergency Shelter			X		$4,000,000	$700,000	$4,700,000
5	Capitola Library -- Backup Emergency Operations Center			X		$10,000,000	$700,000	$10,700,000
6	Capitola Corporation Yard			X		$2,000,000	$500,000	$2,500,000
7	Stockton Avenue Bridge	X				$10,000,000	N/A	$10,000,000
8	Capitola Wharf	Outside of Hazard layer extent				$20,000,000	$300,000	$20,300,000
9	Capitola Beach Sea Wall	X				$5,000,000	N/A	$5,000,000
10	New Brighton State Park--staging area for emergency response		X	X	X	N/A	N/A	N/A

Table 15: **Capitola Critical Facilities Located in a Liquefaction Potential Zone**

Map #	Facility	Very High (A)	High (B)	Low (D)	Undefined (Unkn)	Replacement Value	Contents Value	Potential Loss
11	Cliff Drive -at risk arterial (sea wall and road)			X		$8,000,000	N/A	$8,000,000
12	Park Avenue-at risk arterial (sea wall and road)			X		$4,000,000	N/A	$4,000,000
13	Police Communications Antenna-Capitola Mall			X		$100,000	N/A	$100,000
14	Police Communications Antenna-AAA Building			X		$100,000	N/A	$100,000
15	Noble Gulch Storm Pipe		X			$10,000,000	N/A	$10,000,000
16	38th Avenue Drainage Facility			X		$2,000,000	$300,000	$2,300,000
17	Capitola Pump Station-Esplanade Park				X	$10,000,000	$800,000	$10,800,000
18	Soquel Pump Station	X				$10,000,000	$1,700,000	$11,700,000
19	Lawn Way Storm Drain Pump Station	X				$500,000	N/A	$500,000
20	Soquel Creek Water District Treatment Plant, Garnet Street			X		$2,000,000	$700,000	$2,700,000
21	Soquel Creek Water District Seawater Intrusion Prevention Well, Monterey Avenue			X		$2,000,000	$70,000	$2,070,000
22	Soquel Creek Water District MacGregor Booster Pumping Station			X		$300,000	N/A	$300,000
23	Capitola Beach Flume	X				$2,000,000	N/A	$2,000,000

Table 15: **Capitola Critical Facilities Located in a Liquefaction Potential Zone**

Map #	Facility	Very High (A)	High (B)	Low (D)	Undefined (Unkn)	Replacement Value	Contents Value	Potential Loss
24	Capitola Beach Jetty				X	$3,000,000	N/A	$3,000,000
25	Grand Avenue Cliffs				X	N/A	N/A	N/A
	Total Potential Losses					$125,500,000	$7,645,000	$133,145,000

3.4.2 Coastal Storm/ Flooding

Identifying Coastal Storm and Flooding Hazards

Flooding and coastal storms present similar risks and are usually related types of hazards in Capitola. Coastal storms can cause increases in tidal elevations (called storm surge), wind speed, coastal erosion, and debris flows, as well as flooding.

Coastal storms are generated in the Pacific Ocean and, as they rise over the mountain and ridges that border the eastern boundaries of Santa Cruz County, the air associated with these storms cools, resulting in large amounts of precipitation. The topography of the County provides fairly steep and well defined watershed areas to funnel the falling rain into runoff tributaries. Periods of heavy rainfall are common during fall and winter months causing Soquel Creek, the major drainage course through Capitola, and its tributaries to rise.

During a flood, excess water from rainfall or storm surge accumulates and overflows onto stream banks, beaches, and adjacent floodplains (as illustrated in Figure 4). Floodplains are lowlands adjacent to rivers, lakes, and oceans that are subject to recurring floods. Several factors determine the severity of floods, including rainfall intensity and duration; creek and storm drain system capacity, and the infiltration rate of the ground.

Figure 4 - Flooding Along Soquel Creek Northwest of the Capitola Village (ca. 1996)

A flood occurs when a waterway receives a discharge greater than its conveyance capacity. Floods may result from intense rainfall, localized drainage problems, tsunamis or failure of flood control or water supply structures such as culverts, levees, dams or reservoirs. Floods usually occur in relation to precipitation. Flood severity is determined by the quantity and rate at which water enters the waterway, increasing volume and velocity of water flow. The rate of surface runoff, the major component of flood severity, is influenced by the topography of the region as well as the extent to which ground soil allows for infiltration in addition to the percent of impervious surfaces.

Floodwaters can carry large objects downstream with a force strong enough to destroy stationary structures such as homes and bridges and break utility lines. Floodwaters also saturate materials and earth resulting in the instability, collapse, and destruction of structures as well as the loss of human life.

3.4.3 Profiling Coastal Storm/ Flood Hazards

Location

Capitola Wharf: The Capitola Wharf is located in Monterey Bay and serves as a tourist attraction within Capitola Village. The wharf has a long history within the City, first founded in 1857. The current Capitola Wharf (Figure 5) was constructed in the 1980's following storm damage. It is an 855 foot long structure that contains a bait shop, restaurant, restroom facilities, and free fishing. This wharf is particularly vulnerable to coastal storms.

Figure 5 - View of Capitola Wharf looking South (ca. 2012)

Soquel Creek Watershed: Capitola is located in the lower reaches of the Soquel Creek Watershed, which is located between the cities of Santa Cruz and Watsonville. The Soquel Creek watershed drains an area of approximately 42 square miles. Major tributaries include the West Branch (Burns, Laurel, Hester Creek, Amaya Creek, Fern Gulch, Ashbury Gulch, and Hinkley Creek) and the Main Branch (Moore's Gulch, Grover Gulch, Love Creek, and Bate's Creek). Other tributaries include Noble Gulch, Porter Gulch, Tannery Gulch and Borregas Creek. Principal land use in the watershed includes urban development, rural residential development, agriculture, parks and recreation, and mining and timber harvesting. The Village, a cultural and business center in Capitola, is located at the terminus of Soquel Creek, where it enters the Pacific Ocean. Storm events can result in a significant amount of vegetation debris, which can get blocked at the Stockton Bridge and further exacerbate flood conditions.

Noble Gulch: Noble Gulch is a significant drainage that flows into Soquel Creek at the Capitola Village. Starting in the 1920's, the last 2,000 feet of the Gulch (west of Bay Avenue) was diverted via a 72-inch drainage pipe that extends under the current Pacific Cove Mobile Home Park. During a heavy storm in March 2011, high storm flows in Noble Gulch broke a 72 inch storm drain resulting in flood waters damaging the mobile home park and downstream properties. More information about this event is provided in the *Past Occurrences* section below.

FEMA Special Flood Hazard Area Map: Exhibit 7 - Flood Hazard Zones identifies the 100 and 500 year floodplains as identified by FEMA. The entire stretch of Soquel Creek (within the City limits) and a portion of Noble Gulch creek are located within the 100-year flood zone, which is generally narrow and follows the flow path of the main channel.

Extent

Exhibit 7 identifies the special flood hazard areas within the City of Capitola. These areas are subject to the 100 year flood (1 percent annual chance flood event), 500 year flood (.2 percent annual chance flood event), and coastal flooding (1 percent annual chance flood event with additional hazards associated with storm-induced waves). The TAC noted that occasionally waves from coastal storms do surpass the seawall built in the 1980s, which can cause localized flooding in the Capitola Village. Table 16: FEMA Flood Zones provides definitions of the FEMA Special Flood Hazard Area Zones delineated on Flood Insurance Rate Maps (FIRMs).

Table 16: **FEMA Flood Zones**

Annual Probability of Flooding of 1% or greater (100 Year Flood Zones)	
A	Subject to 100-year flood. Base flood elevation undetermined.
AE or A1-A30	Both AE and A1-A30 represent areas subject to 100-year flood with base flood elevation determined.
AH	Subject to 100-year shallow flooding (usually areas of ponding) with average depth of 1-3 feet. Base flood elevation determined.
AO	Subject to 100-year shallow flooding (usually sheet flow on sloping terrain) with average depth of 1-3 feet. Base flood elevation undetermined.
V	Subject to 100-year flood and additional velocity hazard (wave action). Base flood elevation undetermined.
VE or V1-V30	Both VE and V1-V30 represent areas subject to 100-year flood and additional velocity hazard (wave action). Base flood elevation determined.
Annual Probability of Flooding of 0.2% to 1% (500 Year Flood Zone)	
B or X500	Both B and X500 represent areas between the limits of the 100-year and 500-year flood; or certain areas subject to 100-year flood with average depths less than 1 foot or where the contributing drainage area is less than 1 square mile; or areas protected by levees from the 100-year flood.
Annual Probability of Flooding of Less than 0.2%	
C or X	Both C and X represent areas outside the 500-year flood plain with less than 0.2% annual probability of flooding.
Annual Probability of Flooding of Less than 1%	
No SFHA	Areas outside a "Special Flood Hazard Area" (or 100-year flood plain). Can include areas inundated by 0.2% annual chance flooding; areas inundated by 1% annual chance flooding with average depths of less than 1 foot or with drainage areas less than 1 square mile; areas protected by levees from 1% annual chance flooding; or areas outside the 1% and 0.2% annual chance floodplains.

The potential extent of flooding from Soquel Creek is quantified using the scale depicted in Figure 6. This scale illustrates stage level (water elevation within the creek) and the corresponding stage category (base flow, watch, monitor, flood warning) on the left hand side and past events (included measured flood depth) on the right hand side. Seven events in the past 30 years have exceeded a five year flood event, triggering a flood warning stage along Soquel Creek. Information regarding historic flooding events, including flood depth, are described in the Past Occurrences section of this hazard profile.

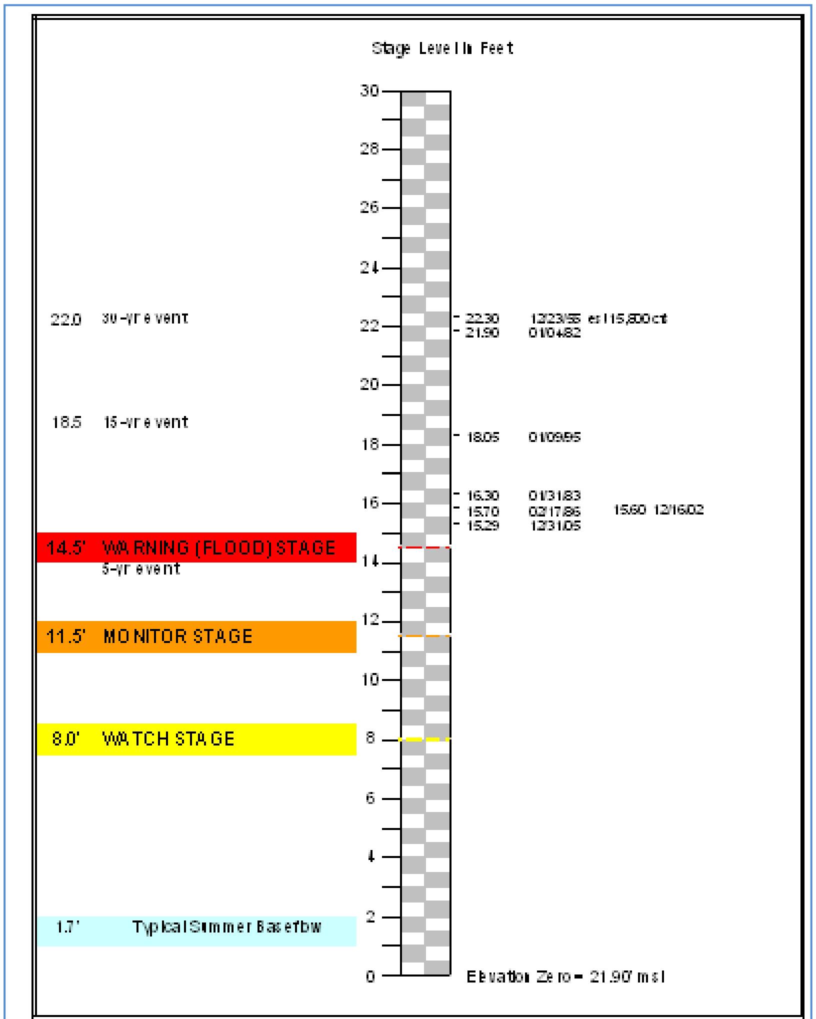
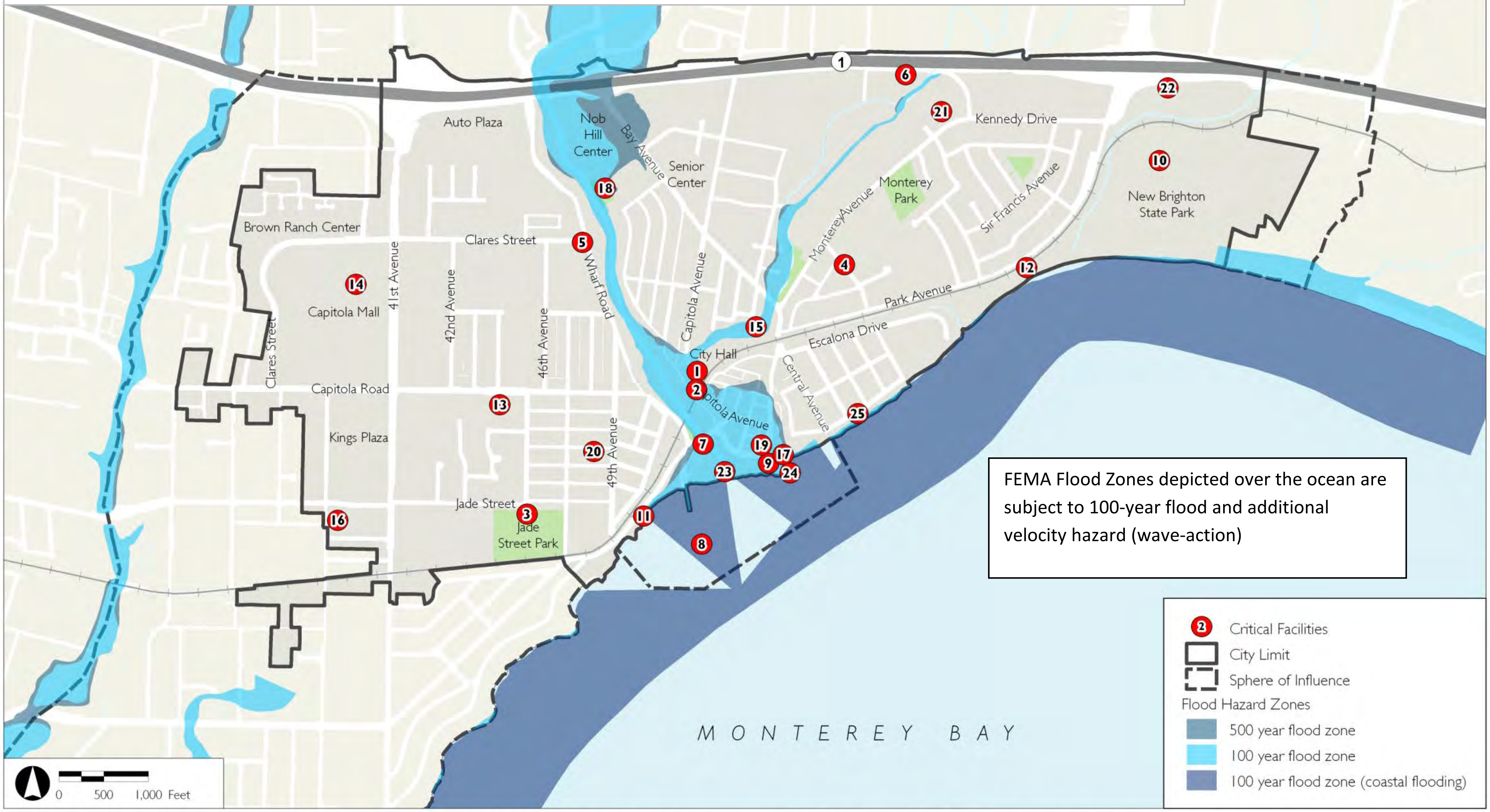


Figure 6 - Soquel Creek Stage Data

(Source: City of Capitola Public Works)

FLOOD HAZARD ZONES
EXHIBIT 7

Note: This map is for planning purposes only and is not intended to be used in lieu of FEMA Flood Insurance Rate Maps.



Source: City of Capitola, 2010; Santa Cruz County, 2011; FEMA DFIRM Santa Cruz County, California, USA. DFIRM Special Flood Hazard Areas (Flood Plains). FIRM and FIS effective date December 1, 2003.

Past Occurrences

Coastal Storm: Past events of storm surge, high surf/tide, flooding, and coastal erosion that have affected the City are identified in Table 17: Historical Coastal Storm and High Surf Events. This information along with the pictures depicting flooding and coastal storm damage in Figures 7 through 9 were provided by the City of Capitola Historical Museum.

Figure 7: Coastal Storm (ca. 1926)

Figure 8: Coastal Storm (ca. 1940)

Figure 9: Coastal Storm (ca. 1983)

Table 17: **Historical Coastal Storm and High Surf Events**

Date	Event	Injury	Impact/Property Damage
January 1862	Storm/Flood		Major event- Soquel village inundated; mills, flumes, school, town hall, houses and barns were destroyed. Massive pile of debris went out to sea and then washed ashore at Soquel Landing.
November 25, 1865	Storm/High Tide		500 feet of the Soquel Landing wharf is lost; the remaining 600 feet are deemed "useless". Nearby barn blown down. Two young whales and a hair cloth sofa washed ashore. Waves described as "mountain high". Wharf damage is $6,000. Pilings are deposited in a potato field beyond the beach.
December 14, 1867	Storm		Wharves damaged in Aptos and Watsonville but no specifics are listed for Soquel Landing.
September 19, 1868	Tidal Wave		High tide described as tidal wave; damage unknown.
February 3, 1869	Storm/ Flood/ Slides/ Washouts		New bridge washed away at Soquel; roads impassable.
December 23, 1871	Southeast gale, food, high tide		Water gauged to be "higher than flood of 1862."
January 24, 1874	Storm		Roaring surf. Rain threatens crops.
January 19, 1878	Storm with Tide		No Capitola impact recorded.
January 30, 1881	Storm		Conflicting reports on damage to Capitola. One report describes the resort as destroyed, while another stated damage was "not as serious"
December 16, 1886	High surf		Capitola impact unknown
December 30, 1886	High surf		High seas; ships prevented from landing.
May 10, 1887	Heaviest surf of the season		No damage reported for Capitola.
January 5, 1889	Storm		Damage to beach areas
December 26, 1889	Storm		Train service stopped; Santa Cruz County becomes isolated.
January 6, 1890	Storm / Mudslides in mountains		Worst winter in 40 years; concern for grain crops
February 8, 1892	High Tides	Swimmers endangered	Yacht "Petrel" washed ashore at Capitola; beachfront concessions damaged.
January 12, 1899	Severe Storm		Duration of several days; damage unknown.
January 2, 1900	Storm		Severe; no damage listed.
March 14, 1905	Storm		Judged to be "worst in 27 years." Capitola impact unknown.
April 27, 1907	Storm		High water and flooding; Capitola damage unknown.
January 21, 1911	Storm		Unknown

Table 17: **Historical Coastal Storm and High Surf Events**

Date	Event	Injury	Impact/Property Damage
March 7, 1911	Storm		Unknown
November 27, 1913	Storm and Tide	Fisherman Alberto Gibelli stranded when mid-section of wharf washed away.	Great groundswells when the tide was highest. Waves ran across the beach to the Esplanade and water spread “clear to the railroad tracks.” Union Traction Company tracks covered with sand. Water reached the Hihn Superintendent’s Building (Capitola and Monterey Avenues), and waves were described as “monster.” About 200 feet washed of wharf washed away. Stranded fisherman rescued and pulled underwater to safety. A huge pile of debris covered the beach and was cut-up for firewood.
November 28, 1919	Storm		Damage high; no Capitola details.
December 27, 1921	Storm		Described as "great".
February 12 and 13, 1926	High Tides		Waves to 20 feet. Wharf damaged. Sea wall promenade broken at Venetian Courts. Apartments flooded. Breakers slammed into Esplanade, destroying boathouse/bathhouse, beach concessions. Tide hits the second floor of Hotel Capitola. Water runs a foot deep through village.
December 26, 1931	Storm		Soquel Creek rises; cleans lagoon at Capitola. Debris and wood deposited on the beach.
December 28 and 29, 1931	Storm and High Tide		Damage to cottages and concessions at New Brighton Beach. Roads fill with “the muck of the sea.” At Seacliff Beach, the concrete ship Palo Alto is shaken loose and moved about three feet as if “impelled by the spirit of the sea to fulfill its destiny and start moving.” Soquel “River” widens to sixty feet, the highest since 1890, damaging property in Soquel and all the way to the mouth at Capitola. Orchards are lost with the rapid rise of water. Hundreds gather to watch the tides batter the concessions at the beach. There is a “vortex of water where the river and sea meet.” The waterfront is piled high with flood debris thrown back up the beach. The creek cuts across the beach and moves sand below the new outlet. Two months later, workers discovered a noticeable settling of the western end of the bathhouse, due to a break in the retaining wall. This left a portion of the bathhouse supported only by its concrete flooring. Repairs required rebuilding the retaining wall and replacing the fill.
March 22 and 23, 1937	Storm		Boats in the streets at Capitola. An estimated $3,000 is spent to repair the sea wall at the Venetian Court Apartments.

Table 17: **Historical Coastal Storm and High Surf Events**

Date	Event	Injury	Impact/Property Damage
January 4, 1939	Wind and Waves		Main damage to Capitola Beach Club at the Esplanade and Monterey Avenue. Water and sand carried into the structure and spread out over the dance floor to the bandstand. While the storm was still raging, thieves jimmied the back door of the club's tap room, and made away with two slot machines, along with the stands on which they had rested. Ocean also swept over the Esplanade during the night, and into town for a block-and-a-half, carrying sand and rocks, some 6-8 inches in diameter. Waves hit the front and sides of the pier. Sand and rocks were swept into lower terraces of the Venetian Court and covered porches of the casino on the waterfront, but did no serious damage.
January 8, 1940 9pm until Noon	Storm		The "old Capitola casino" owned by Capitola Amusement Company was the principal victim of storm. Casino "capsized" shortly after 9 a.m. Plans for new structure announced immediately.
January 12, 1940	Storm		Most rain "since 1890" reported.
January 26, 1940	Storm		"Shatters all records"
March 31, 1940	Storm		"Wettest day in Santa Cruz history."
December 23, 1940	Storm		Flood conditions, winds
February 9, 1941	Storm		Near record storm
April 2, 1941	Severe Storm		Lasting many days. Damage unknown.
August 1, 1949	"Heaviest surf in 20 years"		18 foot waves recorded along the coast. Swimmer drowns in Santa Cruz.
Winter 1953	Giant Swells		Ocean side of building at the end of the Capitola Wharf smashed in by waves 20-30 feet at high tide. Six pilings broken off.
April 3, 1958	High Tide		Esplanade smashed by tides. Andy Antonetti's Merry-go-round damaged; horses are knocked off and washed down San Jose Avenue.
February 9, 1960	Gale winds, heavy seas		Power outages, slides, and winds 35-40 mph. Capitola hardest hit. Damage estimated at $100,000. Ten Venetian Court apartments flooded. "A sign was ripped off the end of the wharf, rolled into a ball, and deposited into an apartment." Heavy waves smashed the beach restaurants, amusement concessions, and the merry-go-round. Rocks and logs strewn across the beach. Water pushed back under the Stockton Bridge, crushing the riverfront fences 100 yards on either side. An estimated $5,000 in damage was done to the wharf building, but not much happened to the wharf itself. Cliffs crumbled on Grand Avenue. Police Chief Marty Bergthold called it "The worst storm in 15 years." A portion of Grand Avenue falls into the ocean.'

Table 17: **Historical Coastal Storm and High Surf Events**

Date	Event	Injury	Impact/Property Damage
December 1965	Storm		The City replaced 21 pilings under the wharf that were weakened by the storm. Capitola officials fear that waves would smash the seawall which protected sewer lines that ran from Capitola's pumping station to the East Cliff Sanitation District plant. That winter, the county public works department offered 500 cubic feet of rock rubble to be placed against the seawall.
January 1967	Storm		Reported as heavy
January 1973	Storm		Beach littered with tons of driftwood after heavy rains.
December 21, 1976	High waves		Waves crash over wharf
January 1978	High waves		Capitola Village streets flooded. Waves crash over wharf.
October 2, 1979	High waves		At least eight sailboats were destroyed at Capitola during the morning. A powerful swell brook 15 boats from their moorings off the Capitola Wharf. The boats were pushed ashore by 12-to-20 foot waves that pounded the shoreline
December 17, 1982	Storm		Restaurant on the newly renovated Capitola Wharf is damaged in storm.
January 27, 1983	High Tide		Capitola Wharf buildings, the Venetian Courts, the former boathouse building (Mr. Toots Downstairs) and all other business of the Esplanade were flooded. Water extends down San Jose Avenue and Lawn Way. Huge logs and debris are scattered through town. The giant surf took out a 30-foot section of the wharf which had been renovated in 1982.
February 10, 1983	High Tide		Surf rolls over the sea wall along the Esplanade. Water and debris extend as far as Capitola Avenue.
March 1, 1983	High Tide/Strong Winds		Waves damaged the restaurant at the end of the wharf, crashed over beach wall and entered restaurants on the Esplanade, "but damage was nothing compared to the million-dollar loss suffered in January," said Capitola City Manager Steve Burrell.
Winter 2008	High Tide		Old bathhouse/boathouse building (Margaritaville/Stockton Bridge Grill) battered by swells. This was the last significant coastal storm/flooding event before 2020 to occur.

Flooding: Table 18: Historical Flood Events identifies notable occasions of flooding as researched by the City of Capitola Historical Museum.

Table 18: **Historical Flood Events**

Date	Injury	Impact/Property Damage
1791-1792		Santa Cruz Mission destroyed.
1847		Sawmill constructed on Soquel Creek (Rancho Soquel) destroyed. It had been built by John Hames and John Daubenbiss, who later obtained lands of the Rancho Rodeo, and became the founders of the town of Soquel (1852).
1852		This was a major flood event but impact not recorded (no newspapers had yet been established).
December 4, 1875		Compared to ferocity of the 1862 flood.
March 10, 1884		Storm lasted five days. No Capitola impact described in newspapers.
January 27, 1890		Judged to be as bad as 1852, 1862, and 1871; Capitola floods, footbridge and span of wagon bridge destroyed. Esplanade flooded—buildings to be replaced in “permanent form.” A huge pile of debris appears along the beach.
January 20, 1906		Buildings from Loma Prieta Lumber Company camp above Soquel are destroyed. Debris at Capitola. Downtown Soquel floods. Landslides in hills.
January 1, 1914		Flood in Soquel and along Soquel Creek.
January 4, 1935		Capitola Village floods; thirty feet of the sea wall is taken out. Beach playground disappears. Venetian Courts hit hard but damage minimal.
February 14, 1937		Soquel Creek floods in Soquel Village due to logjam at the bridge on Soquel Drive. Landslides in watershed.
February 27, 1940		Logs pile against bridge in downtown Soquel and village floods. Landslides in watershed.
February 5, 1945		Local damage unknown.
December 22, 1955		At the Soquel Drive bridge in downtown Soquel, remains of a four-room house and five cabins joined the rubble that wedged against the bridge abutments, causing the bridge to collapse. Overall damage to property in Soquel and Capitola exceeded $1 million. Capitola damage included the Venetian Courts. Noble Creek and Tannery Creek also flooded.
December 20, 1964		Storm and tide alarms City with a disappearing beach.
January 1980		No damage reported.
January 3-5, 1982	Estimated damage to public property: $270,889	Torrential rainfall, floods, mudslides countywide. Soquel Creek overflowed and flooded Soquel. The logjam at the bridge was estimated to be nearly 100 yards wide and 25 feet high. In Capitola, damage was comparatively minimal. The roadway leading to the Stockton Avenue bridge was damaged. The bridge bulkhead was undercut. Several of the Venetian Court units were damaged and a portion of the seawall gave way.
March 1995		The creek rose near the village.
Winter 1996		Yards and basements of homes along both sides of Soquel Creek near the village were flooded.
March 24 and 26, 2011		Noble Creek floods village; Tannery Creek rushes through New Brighton Parking lot and undermines the cliff roadway.

The most recent and damaging event that has occurred in the past 15 years is the 2011 flooding event in Capitola, which is summarized below:

March 2011: Rushing water from a heavy storm overwhelmed an underground pipe drain that sends water from Noble Gulch Creek, which a tributary to Soquel Creek. This event caused a sinkhole at Pacific Cove Mobile Home Park, causing damage to mobile homes and businesses within Capitola Village. Water cascaded down Capitola Avenue into the Village flooding numerous businesses as well as City buildings (Police Station, Fire Station, and City Hall), see Figure 10. The Capitola Public Works Director estimated approximately $500,000 worth of damage to city property, and several million dollars' worth of damage to the city-owned Pacific Cove Mobile Park occurred as a result of this event. According to the National Climactic Data Center (NCDC), property damage county-wide resulting from this flood was estimated at $15.5 million.

This was the last significant flooding event before 2020 to occur

Figure 10 - Flooding within the Capitola Village (ca. 2011)

Sea Level Rise: No considerable events associated with sea level rise have occurred since the 2013 LHMP was approved. However, sea level rise has been an ongoing issue in Capitola due to its location adjacent to the Pacific Ocean and global impacts associated with climate change. As described below in Vulnerability/Risk Assessment, sea level rise is expected to become more severe in future due to projected global increases in sea level.

Probability of Future Occurrence

Coastal Storms: Significant storms, with associated damage, strike the Monterey Bay communities with a frequency of one large storm every 3 to 4 years (Ott Water Engineers, Inc., 1984). This equates to a 25% to 33% chance of a large storm occurring within Capitola in a given year.

Flooding: The FEMA flood zones identified on Exhibit 7 provide the probability of a future occurrence of a flood in Capitola. The probability of occurrence is expressed in a percentage of the change of a flood of a specific extent occurring in any given year. For areas located within the 100 year flood zone, there is a 1% chance in a given year that this area will be inundated by flood waters. For areas located within the 500 year flood zone, this probability decreases to 0.2%. Exhibit 7 also identifies the critical facilities within the City that are located within the 100 and 500 year floodplains.

Climate Change Considerations

Climate change can increase the probability and intensity of both fluvial (river) and coastal storms, which could increase the probability and intensity of flooding in Capitola, particularly in the Village and along the Soquel River.

The City of Capitola Coastal Climate Vulnerability Report (CCWG, 2017) considers flooding and severe coastal storms, which are exacerbated due to sea level rise to be a considerable, potential risk to the City and its residents. Sea level rise has been an on-going progression and due to climate change, this progression has recently and will in the future become more severe.

As shown in Exhibit 8 - Future Combine Coastal Climate Change Hazard Zones (2030, 2060, and 2100), flooding and coastal storm hazard zones were projected and mapped for the years 2030, 2060, and 2100, and quantified in terms of number of damaged or lost facilities and assets and their value (see analysis below). A copy of the report is included as Appendix C and incorporated herein by reference as part of this LHMP update.

Vulnerability/Risk Assessment

Table 19: Capitola Critical Facilities Located in a FEMA Flood Zone identifies the Capitola critical facilities located within the 100 year FEMA floodplain, which have a greater risk to flooding. The potential loss is based on the assumption that all facilities within the 100 year flood zone would be completely destroyed during a coastal storm/flooding event and shows the maximum potential losses. While this is possible, actual losses will vary based on the magnitude of the event. In addition to loss of critical facilities, it is estimated based on 2010 Census Tract data that up to 967 residents located within the City and Sphere of Influence could be impacted by 100 year flood events. This estimate is based on the area of flood impact within each Census Tract multiplied by the population density of the Census Tract. Since the majority of the City's 100 year flood zone is located along Noble Gulch and Soquel Creek, roadways and utility systems (water pump stations, sewer lift stations, storm drains, and overhead electric lines) adjacent to these drainages are most susceptible to flood related hazards.

Table 19: **Capitola Critical Facilities Located in a FEMA Flood Zone**

Map #	Facility	Within 100 Year Flood Zone	Replacement Value	Contents Value	Potential Loss
1	City Hall/Emergency Operations Center	Y	$8,000,000	$750,000	$8,750,000
1	Capitola Police Station	Y	$4,000,000	$750,000	$4,750,000
2	Central Fire Station #4	Y	$3,000,000	$100,000	$3,100,000
7	Stockton Avenue Bridge	Y	$10,000,000	N/A	$10,000,000
8	Capitola Wharf	Y	$20,000,000	$300,000	$20,300,000
9	Capitola Beach Sea Wall	Y	$5,000,000	N/A	$5,000,000
15	Noble Gulch Storm Pipe	Y	$10,000,000	N/A	$10,000,000
17	Capitola Pump Station-Esplanade Park	Y	$10,000,000	$800,000	$10,800,000

Table 19: **Capitola Critical Facilities Located in a FEMA Flood Zone**

Map #	Facility	Within 100 Year Flood Zone	Replacement Value	Contents Value	Potential Loss
18	Soquel Pump Station	Y	$10,000,000	$1,700,000	$11,700,000
19	Lawn Way Storm Drain Pump Station	Y	$500,000	N/A	$500,000
23	Capitola Beach Flume	Y	$2,000,000	N/A	$2,000,000
24	Capitola Beach Jetty	Y	$3,000,000	N/A	$3,000,000
	Total Potential Losses		**$85,500,000**	**$4,400,000**	**$89,900,000**

Combined Impacts of Coastal Climate Change

The California Coastal Commission Sea Level Rise Policy Guidance (November 2018) recommends all communities evaluate the impacts from sea level rise on various land uses. The guidance recommends using a method called "scenario-based analysis". Since sea level rise projections are not exact, but rather presented in ranges, scenario-based planning includes examining the consequences of multiple rates of sea level rise, plus extreme water levels from storms and El Niño events.

In general, the Coastal Commission recommends using best available science (currently the 2018 State of California Ocean Protection Council [OPC] SLR Guidance) to identify a range of sea level rise scenarios, including the low, medium-high, and, as appropriate, extreme risk aversion scenario. These projections are an update from a previous scenario estimate by the National Research Council (NRC) Seal Level Rise study prepared in 2012. A comparison of these two scenarios are shown below in Table 20: Comparison of Sea Level Rise Estimates for Medium-High Risk Aversion for Capitola. The delta between the two methodologies suggests that sea level rise could be greater than previously anticipated, particularly by the year 2100.

Table 20: **Comparison of Sea Level Rise Estimates for Medium-High Risk Aversion for Capitola**

Time Horizon	NRC 2012 Projected SLR	OPC 2018 Projected SLR (Monterey Tide Gauge)	Difference
2030	0.3 ft.	0.8 ft.	0.5 ft.
2060	2.4 ft.	2.6 ft.	0.2 ft.
2100	5.2 ft.	6.9 ft.	1.7 ft.

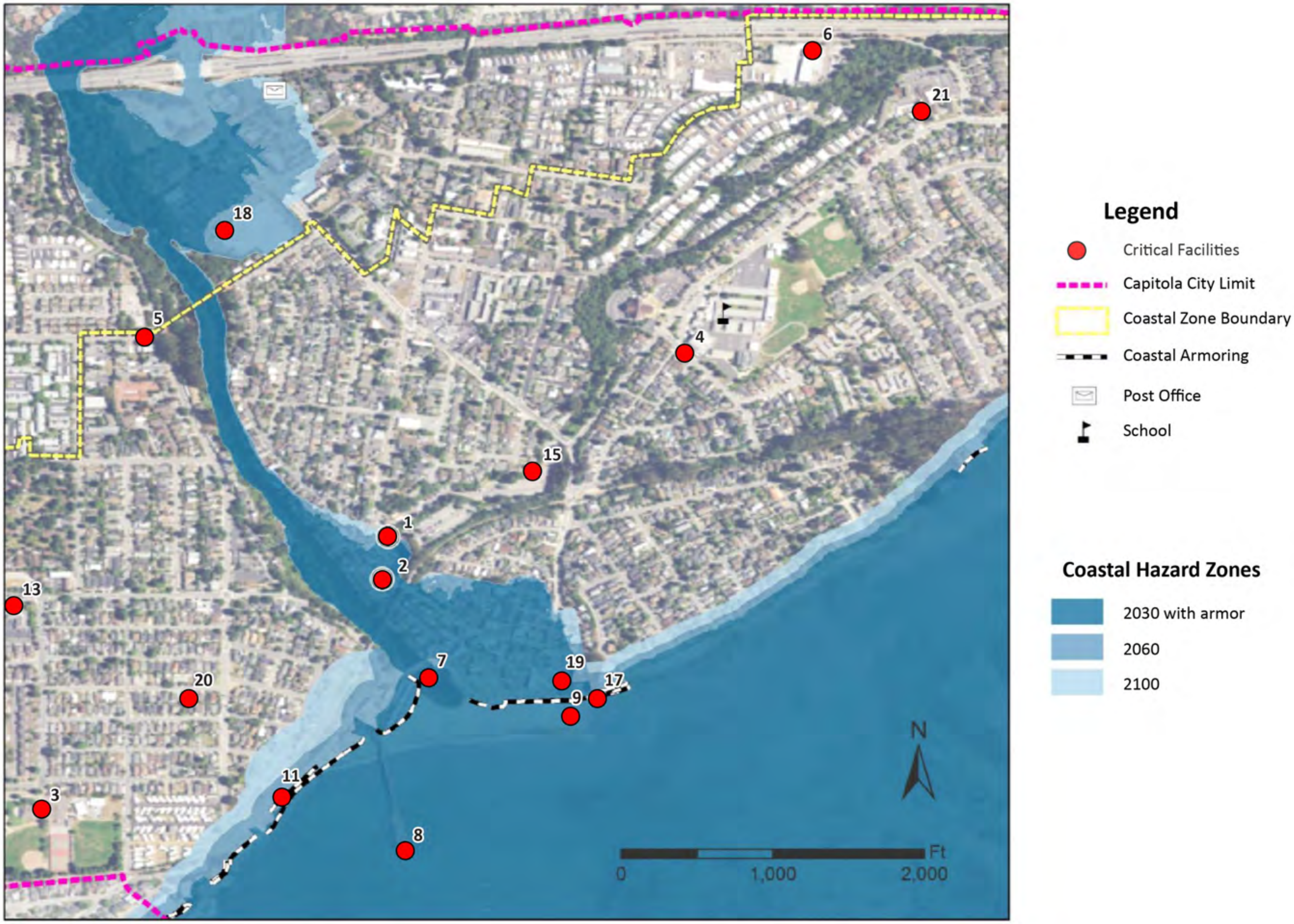
Regardless of the estimates, sea level rise, when combined with coastal storm flooding and rising tides, creates a significant threat to Capitola. For the purposes of assessment of these combined impacts of coastal climate change, the conclusions below are based on the 2017 CCWG City of Capitola Coastal Climate Change Vulnerability

Report (included as part of this LHMP as Appendix C) as it analyzed a comprehensive vulnerability assessment of Capitola's public and private land use and infrastructure assets. Exhibit 8 - Future Combine Coastal Climate Change Hazard Zones (2030, 2060, and 2100) identifies areas of Future Combine Coastal Climate Change Hazard Zones (2030, 2060, and 2100). To the degree these impacts could be greater based on evolving scenario estimates only reinforces the fact that policy planning that addresses the long-range effects of the combined impacts of coastal climate change is an important issue for the City of Capitola.

Key findings from the CCWG report include:

- Infrastructure closest to the beach will continue to be impacted by the force of waves, the deposition of sand, kelp and other flotsam, and by floodwaters that do not drain between waves.
- Infrastructure further inland is most vulnerable to flooding by a combination of ocean and riverine sources.
- Infrastructure identified as vulnerable to coastal flooding by 2030 is similar to that which is currently vulnerable.
- Total property values at risk from the combined hazards of coastal climate change for 2030 were estimated at $200 million.
- Property value at risk may increase to $275 million dollars by 2060. That value is reduced by approximately $50 million dollars if current coastal armoring is replaced or upgraded.
- By 2060 use of all 12 public access ways may be restricted due to various coastal climate vulnerabilities.
- Projected flood water depths along the river walkway are estimated to be as much as 8 feet by 2060.
- Cliff Drive remains a key western access road into the downtown area and is vulnerable to cliff erosion by 2060 if coastal armoring is not replaced.
- By 2100 most of the beach may be lost due to higher sea levels and beach erosion if back beach structures are rebuilt in their current locations.
- As many as 221 properties are within the 2100 bluff erosion zone if protective structures are not maintained or replaced.
- By 2100 SLR and Fluvial models used in this analysis project that much of the downtown area may be periodically flooded during winter storms and high river discharges.
- By 2100 tidal inundation within portions of the downtown area may become a serious challenge, risking 23 residential and 23 commercial buildings to monthly flooding.
- By 2100, portions of Capitola may be too difficult and costly to protect from the combined hazards of Coastal Climate Change.

Exhibit 8 - Future Combined Coastal Climate Change Hazard Zones



3.5 Drought and Water Resources

3.5.1 Identifying Drought Hazards

Drought: A drought is a period of dry weather that persists long enough to cause problems such as crop damage and/or water supply shortages. Droughts can occur in short durations (single year occurrence) or can persist for several years (multi-year) which can impact hydrologic cycles and biologic communities. Droughts may not be predictable, but they should be expected. They occur with some regularity and varying levels of severity. The magnitude and duration of a drought is something that can be predicted based on historical records and should be taken into account in water resource planning.

The City of Capitola receives about 90% of its water supply from the Soquel Creek Water District (SqCWD), while the remaining 10% is supplied by the City of Santa Cruz Water Department (SCWD). In general, SqCWD serves areas of the City that are located east of 41st Avenue and the SCWD serves the portions of the City that are located west of 41st Avenue. Neither agency receives imported water from sources outside of the area, thus both agencies are solely dependent on local water supplies and face a number of critical constraints in their ability to provide enough water to meet current and future demand.

SqCWD obtains 100 percent of its water supply from two groundwater sources within the Soquel-Aptos area. While groundwater sources in general are usually less susceptible to seasonal drought than surface water sources, droughts do impact SqCWD's groundwater supply. Due to cumulative over-pumping for many years, coastal groundwater levels are below elevations that protect the local groundwater basin from seawater intrusion. This condition creates a state of overdraft that is exacerbated by drought conditions to the extent that less rainfall reduces groundwater recharge and generally increases water demand.

The SCWD obtains the majority of its water supply from surface water sources. Approximately 79 percent of its annual water supply needs are met by coastal stream surface diversions, and about 17 percent of its needs are met by Loch Lomond Reservoir. The remaining 4 percent of SCWD's annual supply needs are met by its Live Oak groundwater wells. The SCWD's water supply has limited capacity to serve additional users under normal conditions and has insufficient supply to meet existing demand under drought conditions.

Both water providers have experienced drought periods which resulted in water supply curtailment actions, the most recent occurring from 2007-2009, and both are susceptible to drought conditions in the future. In addition to the 2007-2009 drought, California experienced two other state-wide drought periods within the last forty years: 1976-1977 and 1987-1992.

Groundwater supply: The water supply in Capitola is primarily provided by SqCWD, which has been able to meet historical demand within its service area even though the underlying groundwater basin is overdrafted and at risk from seawater intrusion. In order to recover groundwater levels to protective elevations and eliminate overdraft, SqCWD needs to and is planning on reducing pumping to the Pre-Recovery Pumping Yield of 2,900 acre-feet per year (afy) within approximately 5 years, and maintaining pumping at or below this level for approximately 20 years. For perspective, the SqCWD pumped about 4,000 acre-feet of groundwater in 2011, so an approximate pumping reduction of 30 percent is required to meet the Pre-Recovery Pumping Yield. In response to overdraft conditions and the resulting need to reduce pumping by approximately 30 percent from 2011 levels, SqCWD continues to advocate water conservation and evaluate a desalination project with the SCWD as a supplemental water supply. SqCWD maintains an Urban Water Management Plan[2], which outlines water conservation strategies. SqCWD also completed a Well Master Plan and will be developing up to five new wells over the next five or so years to redistribute pumping inland away from vulnerable coastal areas and to achieve more uniform drawdown of the groundwater basin.

Seawater Intrusion: Seawater intrusion is the movement of ocean water into an area occupied by fresh groundwater, causing chloride contamination of the groundwater. While coastal aquifers naturally experience some seawater intrusion due to the seawater and freshwater interface, freshwater naturally serves as a barrier to seawater moving further inland. However, when coastal groundwater levels are depressed near or below sea level due to over-pumping, seawater can move inland and contaminate groundwater.

The State of California has declared the Santa Cruz Mid-County Groundwater Basin — which supplies water to the SqCWD, Central Water District, City of Santa Cruz, and over a thousand private well users and private mutual systems — as critically overdrafted and mandated that the basin be brought into sustainability by 2040. This mandate affects all basin users, not just the SqCWD.

The SqCWD is solely dependent on groundwater as is most of the Santa Cruz Mid-County area . In addition to the groundwater basin being overdrafted, seawater intrusion is present in Pleasure Point, Aptos, Seascape, and La Selva Beach; data collected in 2017 confirmed the entire coastline is at-risk.

To address this issue, SqCWD is actively working on a groundwater replenishment and seawater intrusion prevention project called Pure Water Soquel. This project will involve taking already treated municipal wastewater from the City of Santa Cruz, purifying it through advanced water purification methods, replenishing the basin through recharge wells, and creating a seawater barrier. One of these recharge wells will be located on Monterey Avenue and replace the existing (now decommissioned) SqCWD Treatment Plant (critical facility # 21). The goal is to have the project operational by 2022.

3.5.2 Profiling Drought Hazards

Location

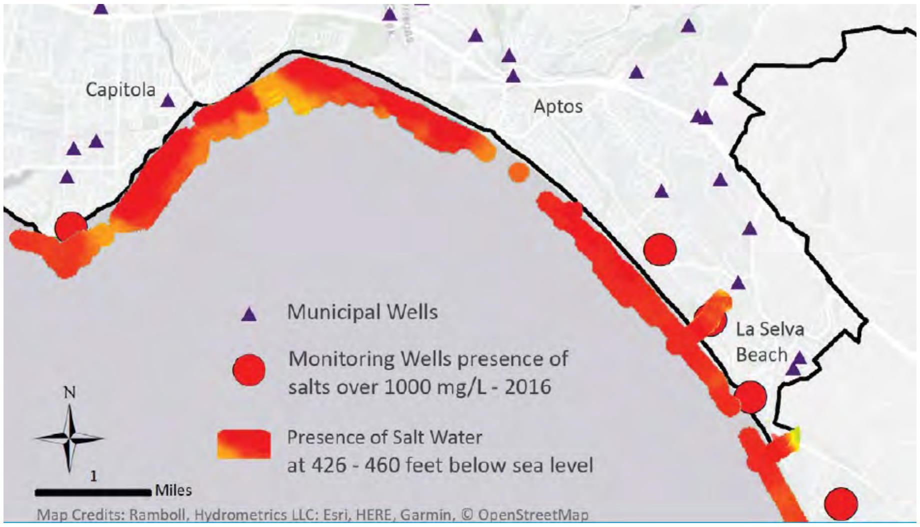
Exhibit 9 - Water Supply illustrates the SqCWD and SCWD boundaries as well as the limits of the local groundwater basin.

Drought: Droughts can occur over large regions (multiple states) or be isolated to small areas such as a City or County. The Santa Cruz County Hazard Mitigation Plan notes the entire county is susceptible to and at risk of drought conditions. Likewise, the City of Capitola is susceptible to drought.

Groundwater Supply: The majority of Capitola is served by the SqCWD, which currently relies solely on groundwater aquifers within the Soquel-Aptos area. The aquifers are located within two geologic formations that underlie the SqCWD service area. The Purisima Formation provides approximately two-thirds of SqCWD's annual production and serves the communities of Capitola, Soquel, Seacliff Beach, and Aptos. The Aromas Red Sands aquifer provides the remaining one-third of SqCWD's annual production and mainly serves the communities of Seascape, Rio Del Mar, and La Selva Beach.

[2] Soquel Creek Water District Urban Water Management Plan

Seawater Intrusion: As shown in the image below, seawater instruction is actively occurring on the Monterey Bay coastline, including Capitola.



Extent

Drought: For a county-wide perspective on the extent of seasonal drought impacts, it is helpful to reference the SCWD since they rely on surface water for water supply. They are able to meet 100% of the existing water demand in about 7 out of every 10 years and at least approximately 90% of existing demand in about 9 out of 10 years. A significant shortage occurs on average about one out of every 10 years.

In addition to water supply shortages, prolonged periods of drought in the Capitola region can exacerbate the potential for wildfires that may affect the City. A decline in water supply can also negatively affect the ability to protect lands from wildfire and/or the City's ability to respond to fire incidents.

Groundwater Supply and Seawater Intrusion:

The Pure Water Soquel project includes facilities in portions of the cities of Santa Cruz and Capitola, and in the Live Oak, Soquel, and Aptos communities of unincorporated Santa Cruz County. The treatment process is planned to be split: tertiary treatment at the Santa Cruz Wastewater Treatment Facility and Advanced Water Purification at the corner of Chanticleer Avenue/Soquel Avenue and the planned three seawater intrusion prevention wells at Monterey Avenue, Willowbrook Lane, and Cabrillo College Drive. The project will; help increase the sustainability of the District's groundwater supply, upon which it currently relies for 100% of its water supply, reduce the degree of overdraft conditions in the District's groundwater basin, protect against and aid in preventing further seawater intrusion of the groundwater basin, and promote beneficial reuse by reducing discharge of treated wastewater to the Monterey Bay National Marine Sanctuary by 25%.

Past Occurrences

Drought: In recent history, Santa Cruz County was impacted by 3 statewide drought occurrences: 1976-77, 1987-1992, and 2007-09. Table 21: Historical Drought Events presents the impacts of drought researched by the City of Capitola Historical Museum.

Table 21: **Historical Drought Events**

Date	Impact/Property Damage
1863-1864	Unknown.
1877	Capitola's founder, S.A. Hall, was boarding 300 horses at his stable during the summer. The price of hay went to $20.00 a ton due to the drought, and he lost money. When landowner F.A. Hihn increased the rent two years later, Hall couldn't afford the increase, and left
1928-1937	Reported as one of longest and most severe in state's history. Capitola is bordered by bulb ranches and floral nurseries, as well as poultry ranches and rabbit farms.
December 14, 1936	Long drought ended by rain.
1947-1949	Statewide.
1976-1977	Water conservation ordered.
1987-1992	Severe drought, water conservation ordered.
2007-2009	Water waste regulations strictly enforced; voluntary 15% conservation savings requested by local water providers.
2013 - 2017	On-going drought conditions resulted in water use restrictions throughout California. This was the last significant drought event before 2020 to occur

Groundwater Supply: The Soquel Creek Water District is currently experiencing a water supply shortfall due to overdraft of the groundwater basin.

Probability of Future Occurrence

Drought: As noted in the Santa Cruz County Hazard Mitigation Plan, one approach to evaluating probability of future events focuses on the magnitude of the worst case drought, because it is the degree of shortfall that determines what actions the community would have to take and the resulting hardships the public would face. It should also take into account, though, the chance of that event occurring before a solution is achieved. The amount of time that elapses before new supply can be developed is an important consideration because it also has a bearing on the degree of risk faced by water customers; the longer the delay, the greater the risk. As with the threat of other natural hazards like a flood or an earthquake, the probability of a severe drought in any one-year may be comfortably low.

For instance, the drought on record of 1977 has a recurrence interval of 1 in 59 years. This means the probability of such an event is 1/59 or 0.017, which is the same as a 1.7% chance of occurrence in any one year. But the percent probability of occurrence, or chance, of a shortage occurring over a longer time frame is considerably higher, which changes the perception of the significance of risk.

Groundwater Supply: The SqCWD Urban Water Management Plan addresses the fact that without incorporating additional conservation methods and a supplemental supply of water to their existing groundwater water supply, the District will be unable to service all water demands in the future without exacerbating overdraft conditions in the basin or imposing significant water use restrictions.

Seawater Intrusion: As discussed above, seawater intrusion in and around Capitola is being addressed by the Pure Water Soquel project.

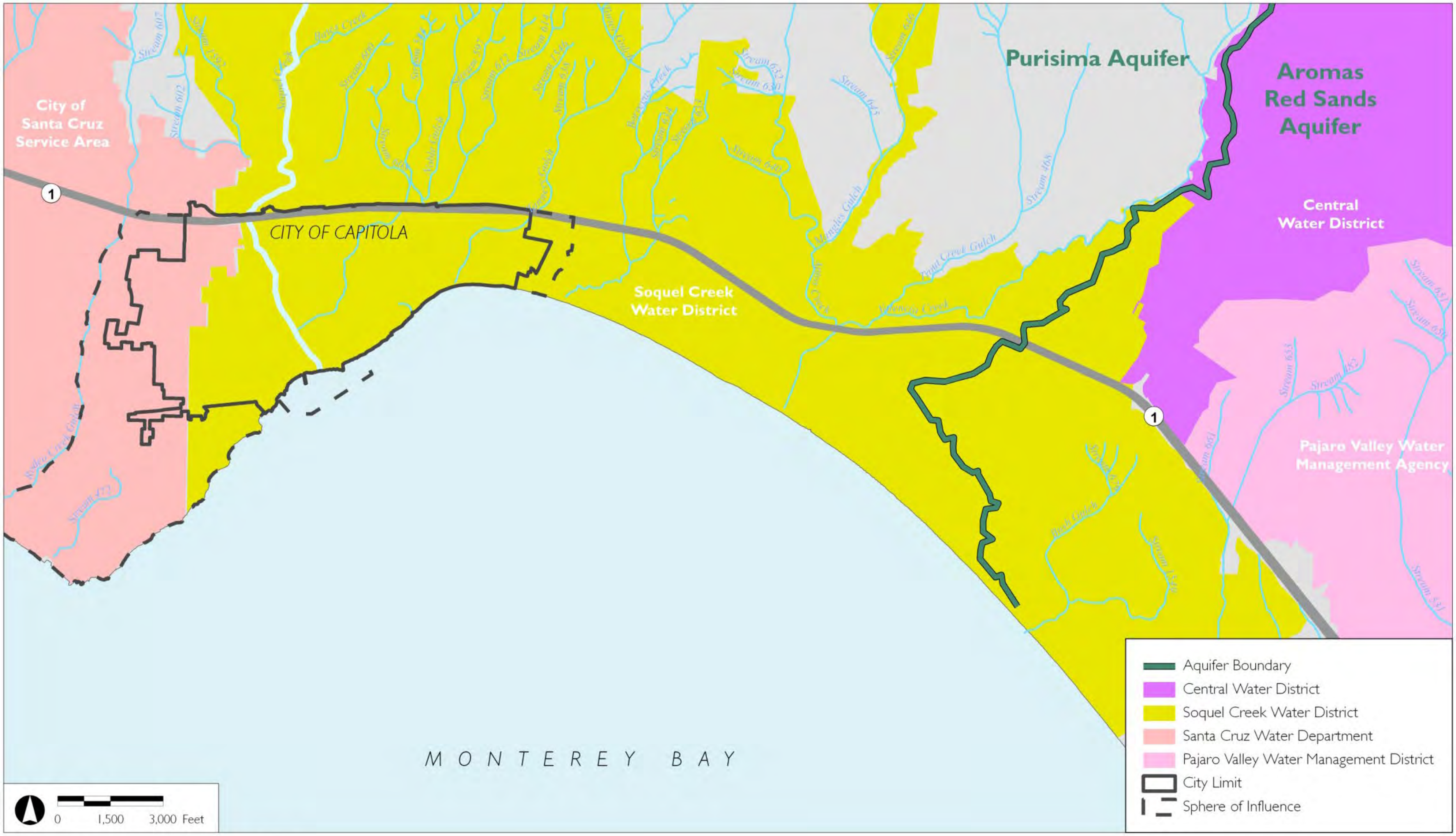
3.5.3 Climate Change Considerations

Per the SqCWD Urban Water Management Plan, consistent future use of the Aromas and Purisima groundwater sources may be affected by climate change. Climate change forecasts indicate a potentially significant decrease (e.g., 30%) in recharge of groundwater basins. Additionally, projected rises in sea level may increase the risk and extent of seawater intrusion. Due to climate change, the City of Capitola may expect more severe droughts of longer duration.

Vulnerability/Risk Assessment

Drought does not inflict physical damage on Capitola's critical assets; however, residents and businesses could be impacted by the water district they are provided by. 90% of the City's water supply is provided by the Soquel Creek Water District, which, although supplied by groundwater and less susceptible to seasonal drought, is susceptible to overdraft. The remaining 10% of the water supply is provided by the City of Santa Cruz Water Department, which is supplied by surface water and is susceptible to seasonal drought. Exhibit 9: Water Supply shows the water district boundaries.

WATER SUPPLY
EXHIBIT 9



Source: City of Capitola, 2010; Santa Cruz County, 2012.

3.6 Windstorm

3.6.1 Identifying Windstorm Hazards

Winds are horizontal flows of air that blow from areas of high pressure to areas of low pressure. Wind strength depends on the difference between the high- and low-pressure systems and the distance between them. A steep pressure gradient results from a large pressure difference or short distance between these systems and causes high winds. High winds are defined as those that last longer than 1 hour at greater than 39 miles per hour (mph) or for any length of time at greater than 57 mph.

3.6.2 Profiling Windstorm Hazards

Location

As illustrated in Exhibit 10 - Prevailing Wind Patterns, Capitola experiences prevailing wind conditions that are generated from the north and northwest, following the California coast. Due to its proximity to the ocean, Capitola also experiences ocean breezes that average between 1-2 miles per hour.

Extent

Since 2004 the highest recorded wind speed in Capitola has reached 46 mph. [3] Wind damage in Capitola may not always be associated with wind, but with tree falls that occur during windy conditions. If soil is saturated due to rain, the trees are more susceptible to falling in the wind.

Past Occurrences

Table 22: Windstorms Reported in Santa Cruz County, California 1965-2011 identifies past high wind, strong wind, and tornado events in Santa Cruz County from 1965 through 2011.

Table 22: **Windstorms Reported in Santa Cruz County, California 1965-2011**

Date	Type of Event	Magnitude	Countywide Property Damage
4/1/1965	Tornado	F1 (73-112 mph)	$0
12/05/1998	Tornado	F0 (40-72 mph)	$50,000
4/3/1999	High Winds	85 MPH	$0
4/4/2001	High Winds	71 MPH	$2,700,000
11/24/2001	High Winds	85 MPH	$7,100,000
12/21/2001	Tornado	F1 (73-112 mph)	$250,000
1/7/2005	High Winds	58 MPH	$0
2/27/2006	High Winds	70 MPH	1 Fatality
12/27/2006	High Winds	40 MPH	$100,000
10/12/2008	Strong Winds	47 MPH	$150,000
1/25/2009	Strong Winds	39 MPH	$25,000
2/15/2009	High Winds	64 MPH	$25,000
4/14/2009	Strong Winds	48 MPH	$70,000
10/13/2009	High Winds	61 MPH	$0
11/28/2009	Strong Winds	43 MPH	$50,000
1/18/2010	Strong Winds	39 MPH	$150,000
1/19/2010	Strong Winds	44 MPH	$200,000

[3] Capitola Weather Net, accessed February 24, 2012. http://www.capitolaweather.net/climate.php

Table 22: **Windstorms Reported in Santa Cruz County, California 1965-2011**

Date	Type of Event	Magnitude	Countywide Property Damage
4/11/2010	Strong Winds	45 MPH	$25,000
10/24/2010	Strong Winds	47 MPH	$15,000
11/20/2010	Strong Wind	48 MPH	$500,000
12/19/2010	Strong Winds	45 MPH	$15,000
12/28/2010	High Winds	50 MPH	$15,000
2/25/2011	Strong Winds	39 MPH	$35,000
11/30/2011	High Winds	56 MPH	$8,000

National Climatic Data Center

http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwevent~storms

Since 2011, NOAA has recorded 11 events with wind speeds 60 knots and higher in Santa Cruz County. The last strong wind event occurred on February 9, 2020.

The City of Capitola Historical Museum researched the historical impacts from wind events as presented in Table 23: Historical Wind Events.

Table 23: **Historical Wind Events**

Date	Injury	Impact/Property Damage
February 10, 1938		Winds up to 70 mph; 500 trees uprooted throughout county.
December 9, 1943		60-mile-an-hour winds create damage in county
1975		40 knot winds downed trees and power lines.
1976 February 9, 2020		Winds downed power lines Winds over 70 mph downed trees and power lines.

In addition to the historical wind events listed above, historical coastal storm events, listed in the flood profile, may also produce wind damage.

Probability of Future Occurrence

Due to its location, it is anticipated that Capitola will experience windstorms in the future. The predominant wind pattern throughout this area is from north to south, however strong winds have been known to occur from other directions as well. It is difficult to predict the amount of damage that could occur from a windstorm with great precision. Based on current modeling and information it is anticipated that most windstorms will follow the general patterns that have historically affected the City. However, what is difficult to predict far into the future is the intensity and duration of a storm. Understanding that windstorm will occur within the City, it is better for the City to determine what potential vulnerabilities exist associated with a windstorm and mitigate these vulnerabilities effectively.

Climate Change Considerations

It is anticipated that wind patterns and windstorm development may be altered due to climate change. The resulting change could increase future storm intensity and duration and potentially change the location of where these storms are generated. With this in mind it will be important for the City to consider how anticipated changes in weather patterns may change future events and how they respond and mitigate hazards associated with windstorms.

Vulnerability/Risk Assessment

The entire City of Capitola and all critical facilities are susceptible to windstorm damage. A majority of windstorm damage that occurs is associated with fallen trees/ tree limbs. Facilities located in close proximity to large trees may be more susceptible to windstorm damage as a result. It is highly unlikely that a windstorm would completely destroy any of the identified critical facilities. However, the replacement values for these facilities may be referenced in Table 7: Capitola Critical Facilities List.

PREVAILING WIND PATTERNS

EXHIBIT 10

Source: City of Capitola, 2010; Santa Cruz County, 2010; ESRI, 2011.

3.6.3 Coastal Erosion/Bluff Failure

Identifying Coastal Erosion/Bluff Failure Hazards

Coastal erosion is the wearing away of coastal land. It is commonly used to describe the horizontal retreat of the shoreline along the ocean. Erosion can be measured as a rate, with respect to either a linear retreat (feet of shoreline recession per year) or volumetric loss (cubic yards of eroded sediment per linear foot of shoreline frontage per year).

Erosion rates are not uniform and vary over time at any single location. Annual variations are the result of seasonal changes in wave action and water levels. Erosion is caused by coastal storms and flood events, changes in the geometry of tidal inlets and bays and man-made structures and human activities such as shore protection structures and dredging.

Coastal erosion includes both cliff and bluff erosion and beach erosion, and is a result of both winter wave attack as well as constant wave action. Beaches change seasonally in response to changes in wave conditions. Winter storm waves are larger, steeper, and contain more energy, typically moving significant amounts of sand from the beaches to offshore sandbars, creating steep, narrow beaches. In the summer, lower, less energetic waves return the sand, widening beaches, and creating gentle slopes. During the winter months when beaches are narrow, or absent altogether, the storm waves attack the cliffs and bluffs more frequently. There are many factors involved in coastal erosion, including human activity, sea-level elevation, seasonal fluctuations and climate change, and sand movement from year to year in the same location.

Wind, waves, and the long-shore currents are some of the driving forces behind coastal erosion. The removal and deposition of sand creates long-term changes to beach shape and structure. Sand may be transported to landside dunes, deep ocean trenches, other beaches, and deep ocean bottoms.

Coastal erosion such as cliff and bluff erosion is also a result of processes related to the land such as rainfall and runoff, weathering, uplift, and earthquakes.

3.6.4 Profiling Coastal Erosion/Bluff Failure Hazards

Location

Capitola is a coastal city, residing within the Monterey Bay area of the Pacific Ocean. The entire coastal edge of the City is affected by coastal erosion. Areas of particular concern include:

Capitola Beach**:** Capitola Beach is a gently rising beach. A jetty located at the eastern edge of the beach has allowed the beach to remain relatively stable. Seasonal changes cause the amount of sand to change whereby winter storms deplete the sand supply, which is then replenished in summer months.

Capitola Cliffs**:** Located along Cliff Drive and the Depot Hill neighborhood. These areas have experienced high levels of coastal erosion (see Figure 11). The cliffs are characterized by gently dipping, late Tertiary sedimentary rocks that are generally overlain by nearly horizontal, quaternary terrace deposits. The local shoreline is nearly parallel to the dominant direction of approach for refracted waves. As a result, littoral drift is rapid, inhibiting formation of a continuous protective beach. Instead, a series of pocket beaches, which are sensitive to seasonal changes and human intervention, have formed. Cliff Drive within this portion of the City has been armored with a rip rap toe and concrete walls along the bluff, which provides erosion protection, however the Depot Hill neighborhood portion is unprotected.

The sanitation district is interested in seeing where the coastal erosion and bluff failure risks are the highest so they can evaluate if it will affect their infrastructure. They are actively planning to relocate sewers based on risk. They use the Capital Improvement Program to budget for these projects.

Extent

Coastal Bluff Failure**:** The historic rate of bluff retreat in Capitola is approximately 0.9 feet per year. If this rate continues, the pedestrian pathway along the cliff area in the Depot Hill neighborhood would be unusable within 10-15 years and the Grand Avenue right-of-way almost entirely gone within 25 years. Assuming this constant rate of retreat, the first houses would be threatened or damaged in approximately 50 years, and most would be damaged or destroyed within approximately 75 years. After 100 years, some of the second-line houses could be threatened.

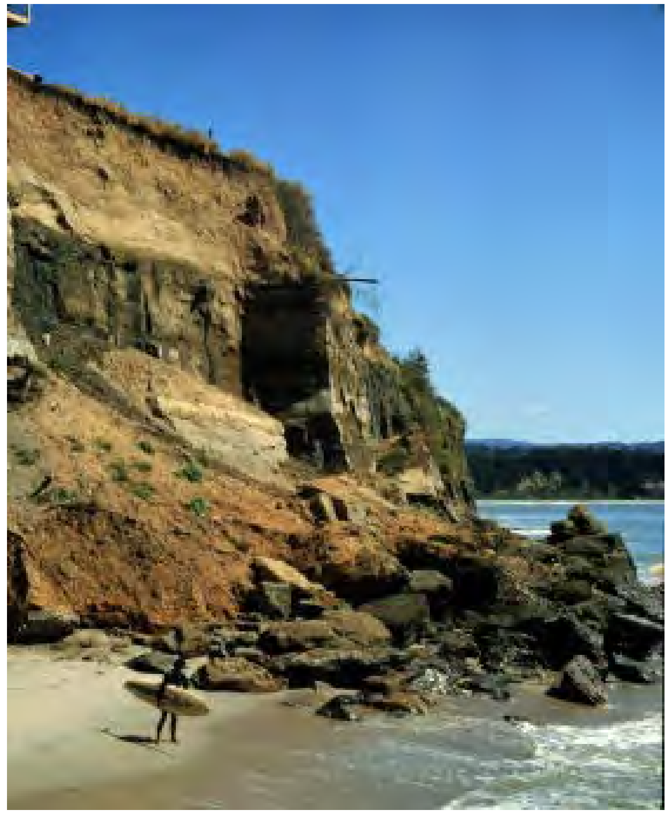


Figure 11 - Episodic coastal bluff failure in Capitola

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Figure 12a - Cliff Erosion Beneath Apartments on Depot Hill (c. 1984)

An example of coastal bluff failure are illustrated in Figures 12a and b. Both sewer and sanitary infrastructure run through the bluffs in Capitola and have the potential to be impacted by bluff failure. In addition, sewer treatment plants are commonly located along the coast of California and are at risk to bluff failure and beach erosion in many locations. In addition, development that has been placed on top of bluffs within Capitola is vulnerable to erosion, as illustrated in Figure 13.

In 2018, the City closed a portion of the Grand Avenue pedestrian pathway between Sacramento Avenue and Oakland Avenue due to concern for bluff failure. On December 2, 2019, a portion of the bluff failed taking with it a portion of the pathway with it.

Figure 12b – Grand Avenue Pedestrian Pathway Erosion

Beach Erosion**:** Beach erosion (as shown in Figure 13) is a seasonal occurrence during the winter months within Capitola. In a 2009 study prepared by the USGS[4], the highest long-term shoreline erosion rates along the California coast were found in the Monterey Bay region, where the average rate of erosion was -0.6 meters/year. The short-

Figure 13 - Capitola Beach Erosion

[4] Rates and Trends of Coastal Change in California and the Regional Behavior of the Beach and Cliff system (http://allenpress.com/pdf/COAS_25.3_603_615.pdf)

term erosion rate was also high, at -0.8 meters/year. These erosion rates not only contribute to the loss of beach sand along the Capitola coast, but also contribute to erosion along the cliffs within this part of the State as well.

Past Occurrences

Although coastal erosion is a continuous process, the rate of erosion is accelerated during times of severe storm activity. The NCDC database captures ocean surf events, which include high tides and surf, rip currents, and storm surge on a county-wide basis. The events noted in the NCDC database that may have contributed to increased coastal erosion in Capitola include:

<u>October 28-29, 1999:</u> A 15 foot swell in association with a relatively high tide produced waves as high as 40 feet which broke through the seawall in Capitola and flooded low lying streets and businesses. The Capitola Wharf was closed because the waves were breaking up through the decking of the wharf. The event caused $1 million in property damage.

<u>February 25, 2004:</u> A strong winter storm brought ocean water onto the Capitola Wharf producing damage on the wharf and adjacent restaurant.

Additional coastal erosion in Capitola's history as researched by the City of Capitola Historical Museum is presented in Table 24: Historic Erosion Events.

Table 24: **Historic Erosion Events**

Date	Impact/Property Damage
1911	Incidents of cliff erosion along Grand Avenue prompt Lewis B. Hanchett, the owner of El Salto Resort, to begin chopping down trees along what is left of "Lover's Lane" along the bluff of Depot Hill. Hanchett believed that when the trees fell, they further hastened the cliff erosion.
January 24, 1930	About 130 residents appear before Santa Cruz County Supervisors to protest announced firing of 12-inch guns at Camp McQuaide, Capitola. Among petitioners claims are that "the terrific jar of the guns loosens the rim of the cliffs, and the earth is sloughing off to a dangerous degree."
January 9, 1935	Near the seawall cave-in by the site of the old hotel, a tree fell sixty feet from Grand Avenue. The "new favorite outdoor sport" for onlookers is to walk behind the sewer plant to see the fallen tree and debris of the broken sea wall.
May 2, 1955	Sentinel: Capitola City Council Asks Cleanup Help "Believe it or not, a few people still occasionally throw garbage over the cliff, particularly along Grand Avenue. This not only creates health hazards, but also attracts rodents which burrow into and weaken the cliff, increasing the rate of cliff erosion…."
1963	Capitola City Council votes to start condemnation proceedings against Harry Hooper to obtain 320 feet of Hooper Beach for erosion control to protect Cliff Drive, where a high rise development was planned.
1963	Capitola City Council considers construction of seawall to control erosion from Grand Avenue to New Brighton Beach. The filled in area would also provide parking for approximately 400 cars.
December 20, 1964	Construction begins on controversial Crest "prestige" 24-unit apartment house on the bay side of Grand Avenue on Depot Hill. Robert Lamberson, architect. Grand Avenue residents eventually sue the City over a disputed 10-foot setback for the project, which was built on a former park site at the top of the bluff. In the 1980s, several units facing the bay were removed due to cliff erosion. $500,000

Table 24: **Historic Erosion Events**

Date	Impact/Property Damage
January 13, 1965	Capitola considers feasibility study to build 370-foot seawall along Grand Avenue. Backfilling below Grand Avenue would be used for a 1,000-car parking lot. Developers expressed desire to lease portion of the parking lot for a three-story, 20 unit convention hotel with restaurant and cocktail bar, to be built along the Grand Avenue bluff. First step was to have the beach deeded to the city by the state. $1,228,000 estimated cost for parking lot $275,000 estimated cost for hotel.
Summer 1965	Capitola requests help from the State Department of Water Resources to solve the problem of disappearing sand, due to "failure of Santa Cruz harbor officials to install a recommended sand by-pass at the harbor jetty.
Summer 1965	Off-Shore parking lot plan revised. Parking lot to extend 430 feet out into the way from the cliffs south of Capitola beach for about 1,500 feet. A breakwater is planned to extend 600 feet south to the end of the high cliff area, to prevent cliff erosion. The parking lot would also be used as an "overnight parking unit" with commercial concessions for tourists. Project to cover ten acres reclaimed from the bay.
1966	Lifelong resident Violet Gooch hired Granite Construction to build a rip-rap wall at the base of the cliff at the end of the row of homes west of the wharf. (Hooper Beach)
1968	Army Corps of Engineers begins work to construct a groin, completed the following spring. $160,000.
February 15, 1984 1984 – present	Even though planner Susan Tupper warned the plan might not be a lasting solution, Capitola City Council approved a plan to stabilize its crumbling cliffs by installing artificial seaweed—a series of floating plastic fronds anchored to a sand-filled tube. The intent was to capture sand that drifts down the coast each year, thereby building a sandy beach in front of the cliffs below Grand Avenue. The "ersatz" seaweed lasted until the next major storm and then drifted to sea. The cliff continues to erode at a rate of 12-18 feet per year. $120,000. Ongoing isolated slope failures have occurred along the Grand Avenue Bluff.

In addition to the past erosion events listed above, coastal storms and high tides can also contribute to erosion and bluff failure. Figure 14 depicts a bluff failure along Grand Avenue that occurred in conjunction with the coastal storm that occurred in 1960. Additional detail of these past events can be found in the flood profile.

Figure 14 - Bluff Failure along Grand Avenue (associated with 1960 coastal storm)

Probability of Future Occurrence

Based on its coastal location, bluff and shoreline erosion will continue to occur in Capitola in the future. The amount of erosion will be dependent on the intensity of future storms and whether or not corrective actions are taken by the City or County to protect shoreline areas by reducing erosion rates. With regard to beach erosion/ bluff failure, it is less a matter of whether or not the hazard will occur and more a matter of the rate in which the hazard will cause additional damage (i.e. structural failure).

Climate Change Considerations

As a coastal community, the potential for sea level rise could increase Capitola's vulnerability to flooding and coastal erosion. The cliffs and sandy beaches that line sections of the Capitola coastline are already susceptible to erosion due to wave attack. It is anticipated that this susceptibility will increase in the event of sea-level rise. In areas not lined with vertical cliffs and bluffs, the depletion of sandy beaches may expose previously protected areas to additional flood hazards.

Exhibit 11 - Erosion Risk from Sea Level Rise, shows the location of future erosion hazard areas in the Year 2100, assuming a 1.4 meter rise in Mean Sea Level. The hazard area is a swath of land approximately 250 feet wide that extends the length of nearly all of Capitola's shoreline, with the exception of a .2 mile gap along the low-lying area at the mouth of Soquel Creek in the Village. Assuming a rise in MSL of 1.4 meters, a total of 40 additional acres of land in Capitola will be vulnerable to bluff erosion hazards. Future vulnerable areas include Cliff Drive and surrounding open space and residential areas in the City's Jewel Box neighborhood, between the Village and New Brighton State Park. In addition, the coastal edge of New Brighton State Park on the east side of the City would be vulnerable to bluff erosion. An estimated 19 acres of land in Capitola would be susceptible to beach erosion in the year 2100, most likely in the low-lying area where Soquel Creek meets the Monterey Bay. At-risk areas include most of Capitola Village on both the south and north side of Soquel Creek.

Vulnerability/Risk Assessment

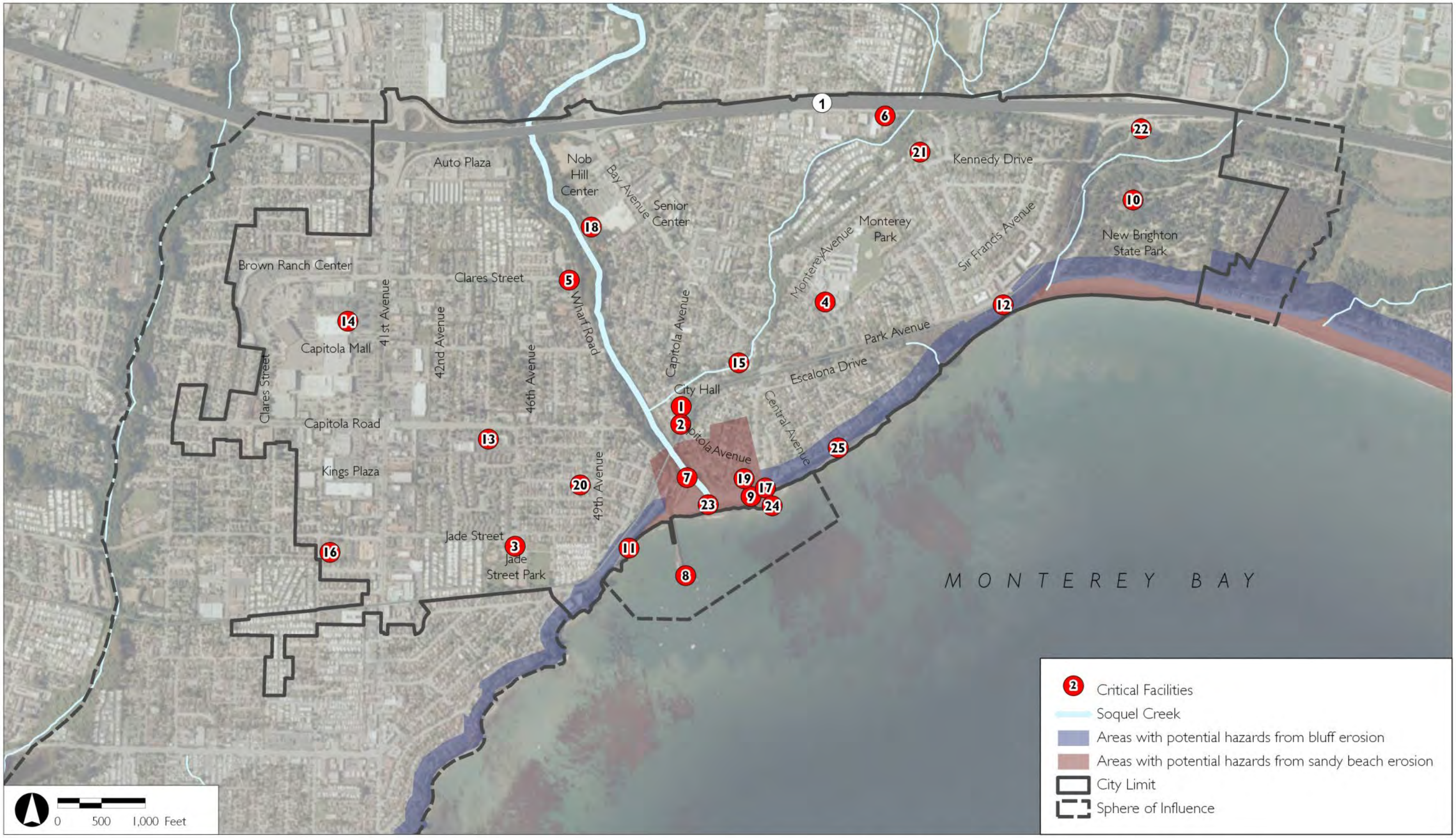
Intersections between critical facilities and areas of beach erosion and cliff erosion were conducted to determine which facilities are at risk to erosion. Based on this analysis, Table 25: Capitola Critical Facilities Exposed to Increased Erosion Potential identifies the facilities that could be impacted by increased beach and/ or cliff erosion in the future. The total potential loss shown in the table below is based on the assumption that all facilities within the beach and cliff erosion potential areas would be completely destroyed during an erosion event and shows the maximum potential losses. While this is possible, actual losses will vary based on the type and magnitude of the event.

Table 25: **Capitola Critical Facilities Exposed to Increased Erosion Potential**

Map #	Facility	Within Area of Beach Erosion Potential	Within Area of Cliff Erosion Potential	Replacement Value	Contents Value	Potential Loss
7	Stockton Avenue Bridge	X		$10,000,000	N/A	$7,000,000
11	Cliff Drive -at risk arterial (sea wall and road)		X	$8,000,000	N/A	$5,000,000
12	Park Avenue-at risk arterial (sea wall and road)		X	$4,000,000	N/A	$3,000,000
17	Capitola Pump Station-Esplanade Park		X	$10,000,000	800,000	$2,800,000
19	Lawn Way Storm Drain Pump Station	X		$500,000	N/A	$200,000
25	Grand Avenue Pathway		X	N/A	N/A	N/A
	Total Potential Losses			$17,200,000	$800,000	$18,000,000

EROSION RISK FROM SEA LEVEL RISE

EXHIBIT 11



Source: City of Capitola, 2010; Santa Cruz County, 2010; Pacific Institute, 2012;The Impacts of Sea-Level Rise on the California Coast. "Bluff erosion hazard with a 1.4 meter sea-level rise, 2100." [shapefile]. (2009). Oakland, CA: Pacific Institute. Available at <http://www.pacinst.org/reports/sea_level_rise/files/Bluff_hz_yr2100.zip>, Downloaded: March 14, 2012.

Discalimer: This map is for planning purposes only. It is not to be used in lieu of site-specific studies of erosion.

3.6.5 Tsunami

3.6.6 Identifying Tsunami Hazards

A tsunami is a series of traveling ocean waves of extremely long length generated primarily by earthquakes occurring below or near the ocean floor. Underwater volcanic eruptions and landslides can also generate tsunamis. In the deep ocean, the tsunami waves propagate across the deep ocean with a speed exceeding 500 miles per hour and a wave height of only one foot or less. Tsunami waves are distinguished from ordinary ocean waves by their great length between wave crests, often exceeding 60 miles or more in the deep ocean, and by the time between these crests, ranging from ten minutes to an hour.

As tsunamis reach the shallow waters of the coast, the waves slow down and the water can pile up into a wall of destruction 30 feet or more in height. The effect can be amplified where a bay, harbor or lagoon is present, funneling the wave as it moves inland. Large tsunamis have been known to rise over 100 feet. Even a tsunami 10 to 20 feet high can be very destructive and cause many deaths and injuries.

Tsunamis can be categorized as "local" and Pacific-wide. Typically, a Pacific-wide tsunami is generated by major vertical ocean bottom movement in offshore deep trenches. A "local" tsunami can be a component of the Pacific-wide tsunami in the area of the earthquake or a wave that is confined to the area of generation within a bay or harbor and caused by movement of the bay itself or landslides. The local tsunami may be the most serious threat as it strikes suddenly, sometimes before the earthquake shaking stops.

3.6.7 Profiling Tsunami Hazards

Location and Extent

The City of Capitola is located on the Monterey Bay. Several active and potentially active earthquake faults are located near Capitola. Even a moderate earthquake occurring on any of the nearby faults could result in local source tsunamis from submarine landsliding in Monterey Bay. Additionally, distinct source tsunamis from the Cascadia Subduction Zone to the north, or Teletsunamis from elsewhere in the Pacific Ocean are also capable of causing tsunamis, which could result in inundation and damage in Capitola.

According to the Cal EMA Tsunami Inundation Maps of the Soquel and Santa Cruz Quadrangles, prepared on July 1, 2009, the entire Capitola coastline is susceptible to inundation by a tsunami. Properties located along Capitola Beach could experience significant damage from tsunami run up. In addition, inland areas of the City along Soquel Creek could experience flooding as far north as California State Route 1 (SR1) following a tsunami.

Exhibit 12 – Tsunami Inundation Risk, identifies the tsunami hazard areas within Capitola based on the Cal EMA Tsunami Inundation Mapping. This mapping is based on a theoretical worst case earthquake causing theoretical worst case inundations that could extend approximately 100 feet inland from the coast, encompassing the Capitola Village up to Cherry Avenue, the Lower Riverview neighborhood, and the Venetian Court area adjacent to Wharf Road. Along Soquel Creek, tsunami inundation could extend north to SR 1, essentially dividing the City in two and potentially limiting access between the eastern and western portions of the City.

Past Occurrences

Tsunamis have been documented extensively in California since 1806. Table 26: Tsunami Events in Northern California 1930-2011, contains a list of tsunamis that have impacted Northern California.

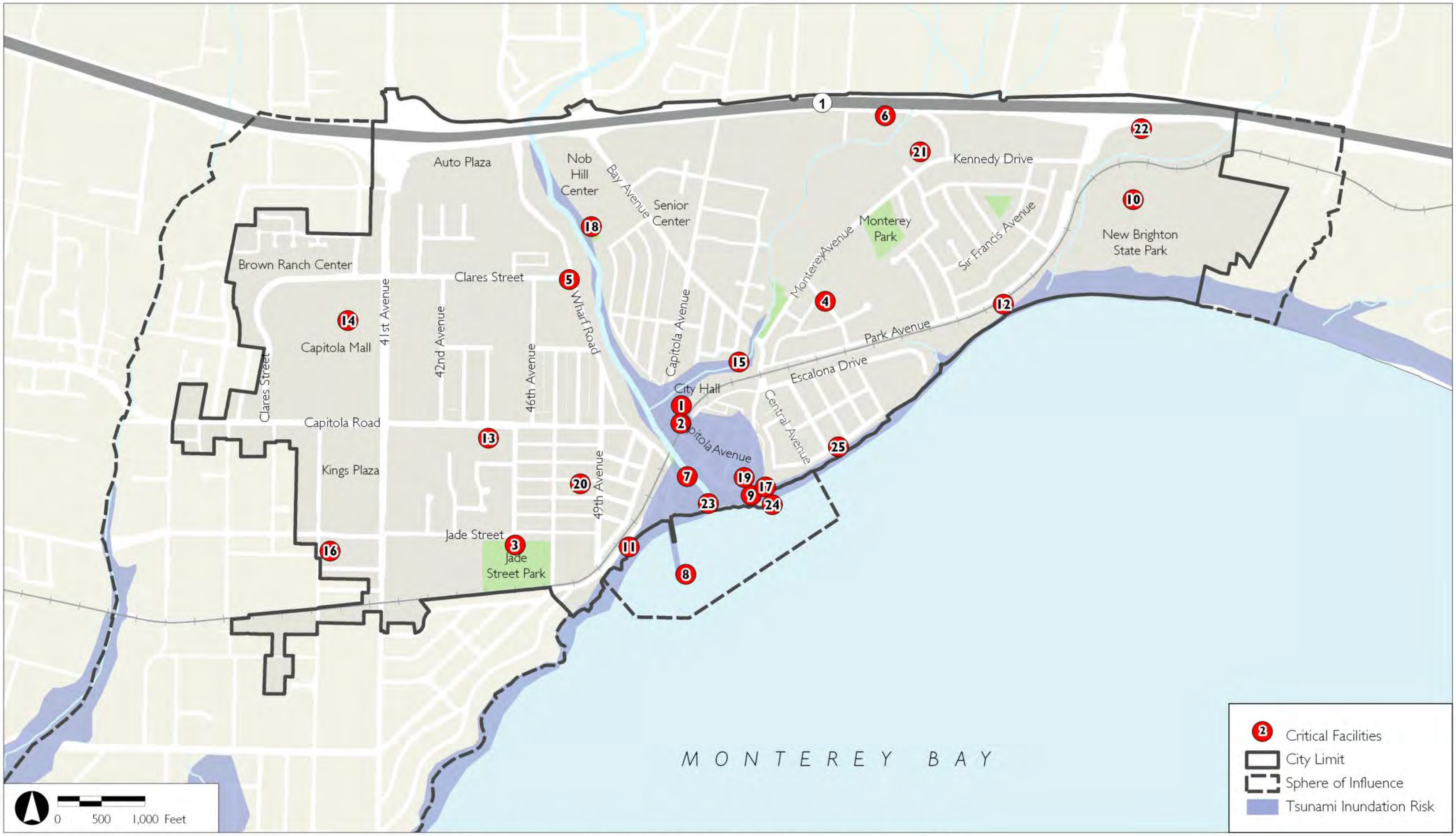
Table 26: **Tsunami Events in Northern California 1930-2011**

Date	Tsunami Location	Maximum Water Height*(m)	Earthquake Magnitude	Tsunami Source Location
10/3/1931	San Francisco	0.03	7.9	Solomon Islands
3/2/1933	San Francisco	0.07	8.4	Sanriku, Japan
11/10/1938	Crescent City	0.18	8.2	Alaska
4/6/1943	San Francisco	0.03	8.2	Chile
12/7/1944	San Francisco	0.02	8.1	Japan
4/1/1946	Santa Cruz	3.5	8.1	Unimak Island, Alaska
12/20/1946	San Francisco	0.05	8.1	Honshu, Japan
3/4/1952	San Francisco	0.02	8.1	Hokkaido, Japan
11/4/1952	San Francisco	0.54	9	Kamchatka Peninsula, Russia
3/9/1957	Monterey	0.61	8.6	Alaska
11/6/1958	San Francisco	0.2	8.3	Kuril Islands, Russia
5/22/1960	Santa Cruz	0.91	9.5	Chile
10/13/1963	San Francisco	0.1	8.5	Kuril Islands, Russia
3/28/1964	Capitola	2.13	9.2	Alaska
2/4/1965	Santa Cruz	0.61	8.7	Aleutian Islands, Alaska
10/17/1966	San Francisco	0.1	8.1	Lima, Peru
5/16/1968	San Francisco	0.1	8.2	Japan
7/26/1971	Crescent City	0.06	7.9	Papua New Guinea
10/3/1974	Crescent City	0.08	8.1	Lima, Peru
11/29/1975	San Francisco	0.06	7.1	Hawaii
5/7/1986	Crescent City	0.06	8	Aleutian Islands, Alaska
11/30/1987	San Francisco	0.05	7.9	Yakutat, Alaska
3/6/1988	San Francisco	0.01	7.7	Alaska
10/19/1989	Monterey	0.2	6.9	California
4/25/1992	Monterey	0.03	7.2	Cape Mendocino, CA
9/1/1994	Crescent City	0.07	7	California
10/4/1994	Crescent City	0.5	8.3	Kuril Islands, Russia
7/30/1995	Monterey	0.04	8	Chile
12/3/1995	Monterey	0.1	7.9	Kuril Islands, Russia
2/17/1996	Monterey	0.05	8.2	Indonesia
6/10/1996	San Francisco	0.02	7.9	Andreanof Islands, AK
6/23/2001	Monterey	0.08	8.4	Peru
9/25/2003	Monterey	0.05	8.3	Hokkaido Island, Japan
12/26/2004	Monterey	0.1	9.1	Indonesia
6/15/2005	Crescent City	0.1	7.2	California
5/3/2006	San Francisco	0.05	8	Tonga
1/13/2007	San Francisco	0.05	8.1	Kuril Islands, Russia
8/15/2007	Crescent City	0.16	8	Peru
9/29/2009	Monterey	0.15	8	Samoa Islands
10/7/2009	Monterey	0.05	7.6	Vanuatu Islands
2/27/2010	Monterey	0.28	8.8	Chile
3/11/2011	Santa Cruz	1.9	9	Honshu Island, Japan

* The maximum water height above sea level in meters NOAA/WDC Tsunami Runup Database
http://www.ngdc.noaa.gov/nndc/struts/form?t=101650&s=167&d=166

TSUNAMI INUNDATION RISK

EXHIBIT 12



Source: City of Capitola, 2010; Santa Cruz County, 2012; Tsunami Inundation Risk of Caliofornia, USC Tsunami Research Center, 2009 via California Resources Agency ArcGIS Map Server.

Table 27: Historic Tsunami Events highlights the tsunami occurrences which impacted the City of Capitola, as researched by the City of Capitola Historical Museum.

Table 27: **Historic Tsunami Events**

Date	Impact/Property Damage*
April 1946	Earthquake in Aleutians produced 115-foot wave. Tsunami observed along the West Coast. A man was swept to sea in Santa Cruz. Ten-foot waves hit the coastline.
March 11, 2011	Capitola Village received warnings, but no damage

* Historical information provided by City of Capitola Historical Museum, 2012.

The March 2011 Tsunami event closed roads in Capitola Village. As a precaution, the City of Capitola issued a voluntary evacuation, notifying individuals through reverse 911, for the hotels on the wharf and a significant portion of the village. They used reverse 911 to issue the voluntary evacuation. Fortunately, it was low tide at the time the tsunami reached the California coast. The water receded past the end of the wharf, which is a very rare occurrence. If the tide was higher, the tsunami could have been large enough to overtop the seawall. No significant damage occurred from the tsunami event. This was the last Tsunami event before 2020 to occur.

Probability of Future Occurrence

Since scientists cannot predict when earthquakes will occur, they cannot determine exactly when a tsunami will be generated. Tsunamis are caused by large offshore earthquakes and ocean landslides. Dangerous tsunamis would most likely originate in the Aleutian and Chilean trenches, or the eastern coast of Japan or the Pacific Islands.

Based on modeling prepared by the California Geologic Survey, Tsunami Flow Depth Estimates for Capitola are provided in Table 28: Tsunami Flow Depth Estimates for Capitola. This table identifies the modeled source location of the earthquake event, magnitude of the modeled earthquake, approximate travel time and maximum flow depth values of the waves generated by the event. As indicated in this table Capitola is most susceptible to Tsunamis generated in the Alaska/ Aleutian Islands area as well as a local tsunami generated by a landslide within the Monterey Canyon.

Table 28: **Tsunami Flow Depth Estimates for Capitola**

Tsunami Source Location	Magnitude (Mw)	Approximate Travel Time	Tsunami Flow Depth (in feet above MSL)
Cascadia Subduction Zone	9.0	1 hour	5
Alaska/ Aleutian Islands	8.9-9.3	5 hours	7 - 30
Kuril Islands	8.8	9 hours	4 - 5
Japan	8.8	10 hours	4
Marianas Subduction Zone	8.6	11 hours	3
Chile	9.3-9.4	13-14 hours	4-6
Monterey Canyon Landslide*	N/A	7-15 minutes	16

*A Monterey Canyon Landslide could be triggered by an average earthquake.

Capitola is participating in the Tsunami Ready Program in order to mitigate the effects of future tsunamis. The Tsunami Ready Program is designed to help cities, towns, counties, universities, and other large sites in coastal areas reduce the potential for disastrous tsunami-related c consequences. Tsunami Ready status is achieved through a vigorous certification program that includes planning, communication, and education specifically addressing tsunami hazards. As part of this program, tsunami inundation maps, evacuation maps, and a tsunami ready signage plan, indicating the perimeter of an inundation zone and the appropriate action to be taken by individuals on the beach when an earthquake occurs, were created.

Climate Change Considerations

As a coastal community, the threat of inundation from a Tsunami is always there. Given the anticipated changes in sea level elevation associated with climate change, it is likely that the City's risk to tsunami inundation would increase. With a sea level increase, larger portions of the Capitola coast would be inundated by the rising sea, allowing for greater tsunami run up into the interior portions of the City. The main areas that would experience inundation due to sea level rise are the lower reaches of Soquel Creek and coastal areas of New Brighton State Park. Since these same areas are also susceptible to tsunami inundation, it is likely that additional areas along the periphery of the zone identified on Exhibit 12 would experience run up as sea level increases.

Vulnerability/Risk Assessment

Table 29: Capitola Critical Facilities Exposed to Tsunami Inundation identifies the critical facilities that are potentially at risk during a tsunami event. Depending on the location or origination, severity of movement, and time of year when the event occurs, these facilities could be impacted by tsunami inundation. The total potential loss shown in the table below is based on the assumption that all facilities within the tsunami inundation zone would be completely destroyed during a tsunami event and shows the maximum potential losses. In addition to loss of critical facilities, it is estimated based on 2010 Census Tract data that up to 1,694 residents located within the City and Sphere of Influence could be impacted by tsunami inundation. This estimate is based on the area of flood impact within each Census Tract multiplied by the population density of the Census Tract. A majority of the impact would occur along the shoreline and within the Capitola Village area of the City. Roadways and utility systems (water pump stations, sewer lift stations, storm drains, and overhead electric lines) within these areas are most susceptible to tsunami hazards. While this is possible, actual losses will vary based on the magnitude of the event.

Table 29: **Capitola Critical Facilities Exposed to Tsunami Inundation**

Map #	Facility	Within Tsunami Inundation Zone	Replacement Value	Contents Value	Potential Loss
1	City Hall/Emergency Operations Center	Y	$8,000,000	$750,000	$4,750,000
1	Capitola Police Station	Y	$4,000,000	$750,000	$2,750,000
2	Central Fire Station #4	Y	$3,000,000	$100,000	$1,100,000
7	Stockton Avenue Bridge	Y	$10,000,000	N/A	$7,000,000
8	Capitola Wharf	Y	$20,000,000	$300,000	$7,300,000
9	Capitola Beach Sea Wall	Y	$5,000,000	N/A	$3,000,000
11	Cliff Drive -at risk arterial (sea wall and road)	Y	$8,000,000	N/A	$5,000,000
15	Noble Gulch Storm Pipe	Y	$10,000,000	N/A	$5,500,000
17	Capitola Pump Station-Esplanade Park	Y	$10,000,000	$8,000,000	$10,000,000
19	Lawn Way Storm Drain Pump Station	Y	$500,000	N/A	$200,000
23	Capitola Beach Flume	Y	$2,000,000	N/A	$2,000,000
24	Capitola Beach Jetty	Y	$3,000,000	N/A	$3,000,000
	Total Potential Losses		**$83,500,000**	**$9,900,000**	**$51,600,000**

3.6.8 Hazardous Materials

Identifying Hazardous Material Release Hazards

"Hazardous materials" covers a large number of substances that are a danger to the public. These include toxic metals, chemicals, and gases; flammable and/or explosive liquids and solids; corrosive materials; infectious substances; and radioactive materials. The City of Capitola has adopted a Hazardous Materials Ordinance which requires that the City be notified of all use, storage, and transport of hazardous materials.

In addition to the immediate risk to life safety, public health, and air quality, the potential for water source contamination and the potential environmental impacts of accidental hazardous materials releases and toxic substances, there is also concern over the long-term public health and environmental impacts that may result from the sustained use of or exposure to certain substances. An incident could result in the evacuation of a few people, a section of a facility, or an entire neighborhood.

Profiling Hazardous Material Release Hazards

Location and Extent

Hazardous materials are everywhere and are accidentally released or spilled many times during any given day. On average, the California State Warning Center receives eight to ten thousand hazardous material spill reports on hazardous material incidents and potential hazardous material incidents. Of these incidents, most are minor but some do cause significant impacts such as injuries, evacuation, and the need for cleanup. As illustrated in *Exhibit 13 - Hazardous Materials Locations*, the western portion of Capitola contains the majority of City's hazardous materials locations, with a significant number of locations located along 41st Avenue.

One area of special concern regarding toxic spills is the close proximity of the Capitola Auto Plaza Mall and Highway One, to Soquel Creek. In case of a hazardous materials spill from either location, the discharge could migrate into Soquel Creek. Another concern regarding hazardous materials spills is the potential for chemicals and substances to migrate into the groundwater table. Since a majority of the City is served by Soquel Creek Water District which relies on groundwater, any potential contaminants entering the groundwater aquifer could impact the District's ability to serve its customers.

Past Occurrences

Table 30: RIMS Spill Database for Capitola, CA contains a list of spills documented on the CalOES's (CalEMA) Regional Information Management System (RIMS) between 2006 and the beginning of 2012. Since 2006 there have been 14 cases documented within Capitola, which equates to an average of approximately 2.7 spills per year. One historic event documented by the Capitola Historical Museum includes birds known as Sooty Shearwaters falling from the sky in the summer of 1961 due to toxins from red algae. The birds covered the streets, wharf, and beach.

Probability of Future Occurrence

Although past occurrences can be an indicator of future impacts, in the case of hazardous materials spills, the City is constantly improving the mechanisms by which they approve and regulate businesses that use hazardous materials. In addition, technological advances and increases in industry standards are also improving safety and further preventing/ minimizing potential releases of hazardous materials. As a result, it is anticipated that future incidents will decrease over time as newer technologies, standards, and regulations are put in place.

Table 30: **RIMS Spill Database for Capitola, CA**

Date	Spill Site	Substance
2/6/2006	Storm Drain	Raw Sewage
4/24/2006	Railroad	Unknown
5/12/2006	Road	Raw Sewage
7/4/2006	Waterways	Unspecified
8/13/2006	Merchant/Business	Raw Sewage
4/3/2007	Residence	Raw Sewage
4/26/2007	Railroad	Unspecified
2/22/2009	Merchant/Business	Raw Sewage
3/23/2009	Other	Raw Sewage
4/27/2011	Residence	Other
7/9/2011	Ship/Harbor/Port	Petroleum
7/9/2011	Waterways	Petroleum
8/1/2011	Waterways	Petroleum
1/20/2012	Merchant/Business	Chemical

Hazardous Materials Spill Report http://www.oes.ca.gov/operational/malhaz.nsf

The chemical spill on January 20, 2012 is the last known significant hazard event before 2020 to occur in Capitola.

Climate Change Considerations

Anticipating that precipitation regimes may change in the future as a result of climate change, there may be greater opportunity for the release of hazardous materials to enter local waterways and the groundwater aquifer.

It is anticipated that if this concern increases that the City and other regulating agencies would re-visit procedures and practices in place to ensure that the greatest amount of protection occurs.

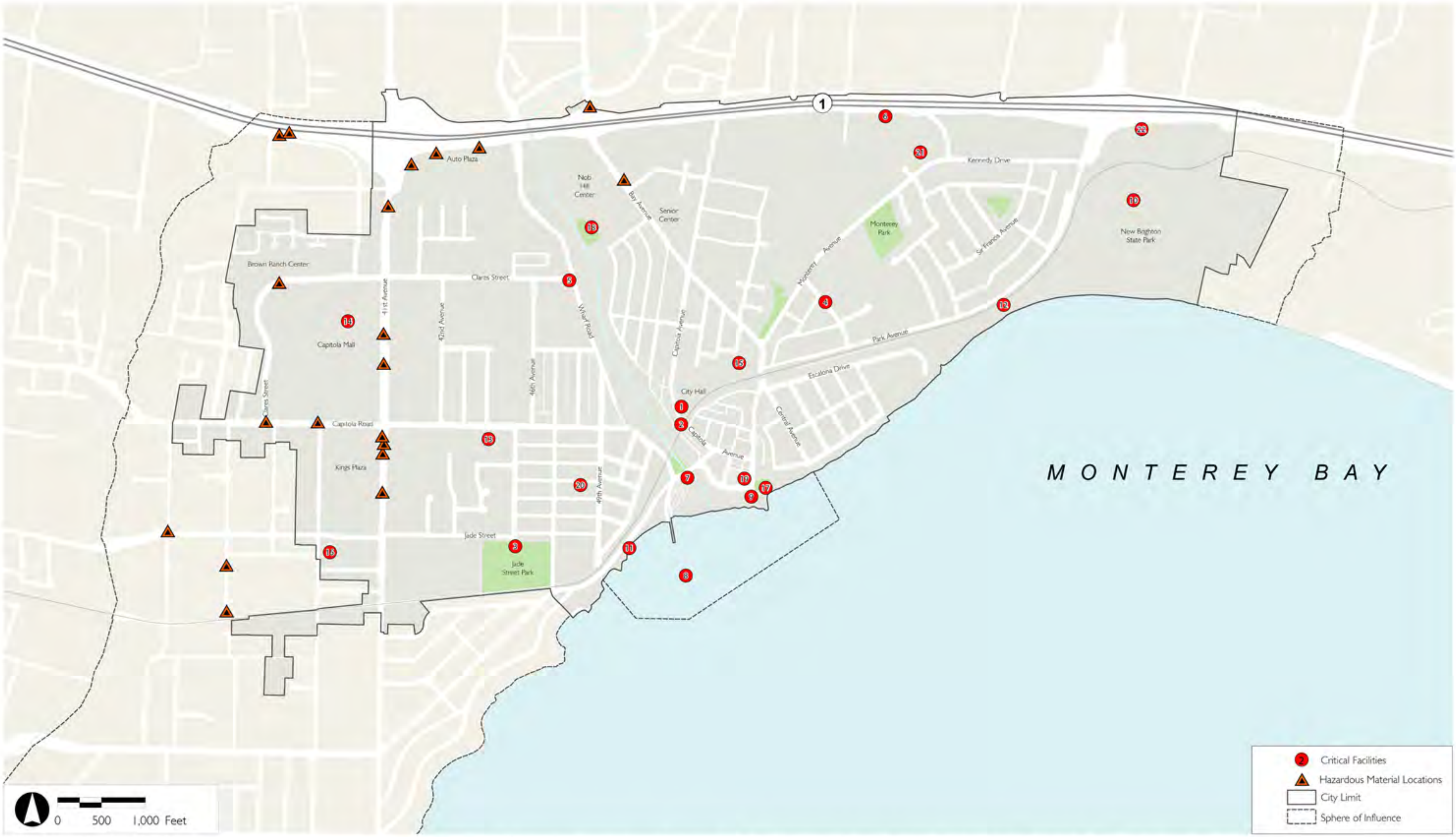
Vulnerability/Risk Assessment

Table 31: Capitola Critical Facilities Located Close to Hazardous Materials Locations identifies locations that could be exposed to hazardous materials releases during a disaster event. These locations only take into consideration the proximity to existing hazardous materials facilities and do not include potential exposure associated with the movement/ transport of hazardous materials. The total potential loss shown in the table below is based on the assumption that all facilities within 1,000 feet of a hazardous materials facility would be completely destroyed during a hazardous materials release/event and shows the maximum potential losses. While this is possible, actual losses will vary based on the location and magnitude of the event.

Table 31: **Capitola Critical Facilities Located Close to Hazardous Materials Locations**

Map #	Facilities	Hazardous Materials within 500'	Hazardous Materials within 1000'	Replacement Value	Contents Value	Potential Loss
14	Police Communications Antenna-AAA Building	X	X	$100,000	N/A	$100,000
16	38th Avenue Drainage Facility		X	$2,000,000	$300,000	$2,300,000
18	Soquel Pump Station		X	$10,000,000	$1,700,000	$11,700,000
17	Capitola Pump Station – Esplanade Park		X	$10,000,000	$800,000	$10,800,000
	Total Potential Losses			**$22,100,000**	**$2,800,000**	**$24,900,000**

HAZARDOUS MATERIALS LOCATIONS
EXHIBIT 13



Source: City of Capitola, 2010; Santa Cruz County, 2011; Environmental Protection Agency (EPA) Resource Conservation and Recovery Act (RCRA) Information System, "Facilities Regulated by EPA" (April 17, 2009). Washington D.C, U.S. Environmental Protection Agency, Headquarters. Available at <http://www.epa.gov/emefdata/em4ef.home>, Downloaded February 3, 2012.

3.6.9 Wildfire

Identifying Wildfire Hazards

Fire hazards threaten lives, property, and natural resources, and also present a considerable risk to vegetation and wildlife habitat. Fires occur in wildland and urban areas.

A wildfire is an uncontrolled fire spreading through vegetative fuels. Wildfires can be caused by human error (such as campfires), intentionally by arson, by mechanical sources of ignition (such as heaters and generators), and by natural events (such as lightning). Wildfires often occur in forests or other areas with ample vegetation. In areas where structures and other human development meets or intermingles with wildland or vegetative fuels (referred to as the "wildland urban interface"), wildfires can cause significant property damage and present extreme threats to public health and safety.

Urban fires usually result from sources within structures themselves and are generally related to specific sites and structures. The availability of firefighting services is essential to minimizing losses that result from a fire. Effective fire protection in urban areas is based upon several factors, such as the age of structures, efficiency of circulation routes (ultimately affects response times), and availability of water resources to combat fires.

3.6.10 Profiling Wildfire Hazards

Location and Extent

As indicated in Exhibit 14 - Fire Hazard Areas, there are no fire hazard areas located in the City of Capitola based on the available fire mapping for Santa Cruz County. However, fire hazard areas do exist two miles north of the city limits along the foothills of the Santa Cruz Mountains.

In addition to the mapped fire hazard areas within the County, the areas that are most susceptible to fire hazards are drainage courses that have a significant amount of vegetation within them such as Soquel Creek. It is likely that these areas within the City would experience fires due to natural or man-made causes. The wildland threat for Capitola is increased due to localized invasive species such as Eucalyptus groves.

Past Occurrences

There are no significant wildfire events that have impacted the City of Capitola.

Probability of Future Occurrence

Despite the fact that there has not been a recent wildland fire within the city limits, residential development continues to spread into wildland/urban interface areas increasing the danger to life and property should a fire occur. Areas of concern associated with wildland fire are those adjacent to natural areas that are heavily vegetated (i.e. Soquel Creek). These areas are even more susceptible if human activities are allowed within, as these activities can introduce new ignition sources into these areas.

Cal FIRE has not identified fire hazard areas within the City of Capitola. Based on this, threats to populations and systems associated with wildland fires are anticipated to be minimal. However, a fire threat will always exist in a wildland/urban interface area as long as vegetation, trees, down and dead fuels, structures and humans co-exist. There is a high probability that fires will occur in one or more of these areas.

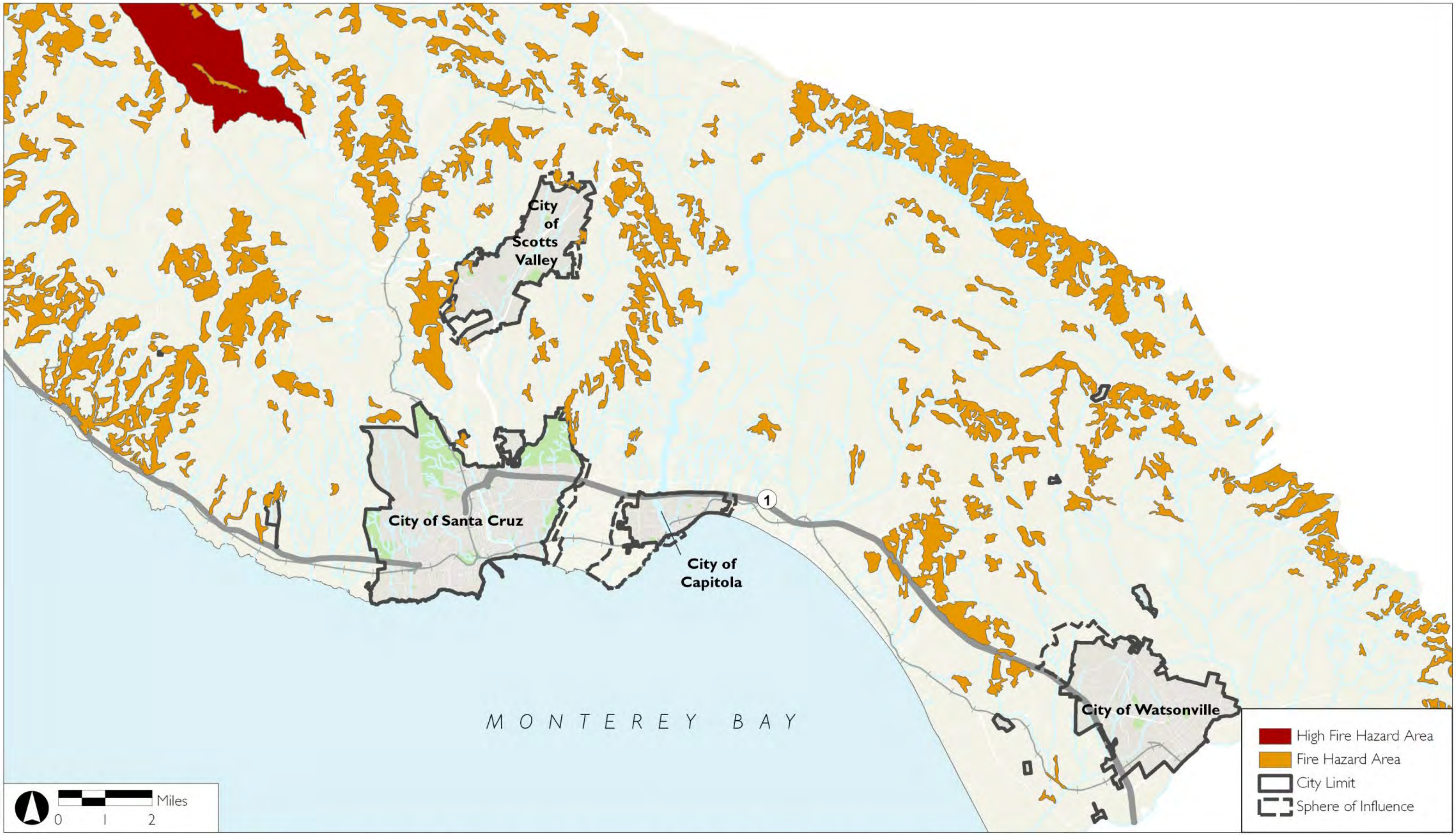
Climate Change Considerations

Anticipating that precipitation regimes may change in the future as a result of climate change, there may be greater opportunity for wildfire hazards throughout the State of California. Increases future droughts and hotter temperatures could increase fuel loads within wildland areas increase the risk associated with wildland fires.

Vulnerability/Risk Assessment

As indicated in Exhibit 14 - Fire Hazard Areas, there are no fire hazard areas located in the City of Capitola based on the available fire mapping for Santa Cruz County. Intersections between critical facilities and fire hazard areas were not conducted since these areas are not within the City.

FIRE HAZARD AREAS
EXHIBIT 14



Source: City of Capitola, 2010; Santa Cruz County, 2010; Emergency Management. "Fire Hazard Areas." [shapefile]. (2010). Santa Cruz County Geographic Information System File Download Site. Available at <http://sccftpmap.co.santa-cruz.ca.us/File%20Download%20Site/Emergency%20Management/Shapefiles/EmergencyMgmt.zip>, Downloaded: January 29, 2011.

3.7 Landslide and Mudflow

3.7.1 Identifying Landslide and Mudflow Hazards

General slope stability is determined by a number of factors such as the angle of the slope, vegetative cover, wildland fire, bedrock, soil, seismic activity, precipitation, groundwater, erosion, and human alterations to land such as hillside grading activities. Slopes may be in temporary equilibrium until one of the aforementioned factors is modified by natural or human activity resulting in an unstable condition and potential slope failure.

Figure 15 - Debris generated during the Flash Floods (ca. 1955)

A landslide is defined as a downward and outward movement of soil and rock. Such a movement occurs when steep slopes are destabilized by excess water accumulation in the soil, the addition of excess weight to the top of a slope, the removal of support from the bottom of a slope, or a combination of the above. The force of rocks, soils, or other debris moving down a slope can devastate anything in its path as illustrated in Figure 15.

Mudflows, often referred to as "debris flows" or "mudslides" are caused by sustained and intense rain fall that is accompanied by rocks, vegetation and other debris. These are fast moving down slope flows and can cause severe damage. The rapid movement and sudden arrival of debris flows pose a hazard to life and property during and immediately following the triggering rainfall. In order to trigger "debris flows" a storm must have a critical combination of rainfall intensity and duration leading to saturation of the hill slope soils, generation of positive pore fluid pressures within the soil and ultimately, slope failure.

Examples of common impacts can include death and injuries, damage to structures and infrastructure, environmental damages (such as destruction of plant life and habitat), economic impacts, impacts to continuity of business and/or government, etc. They can be general statements as they apply to the City.

3.7.2 Profiling Landslide and Mudflow Hazards

Location and Extent

Landslides are a common occurrence in the Santa Cruz Mountains. Intense winter storms, high rainfall amounts, and steep terrain are all conducive to land sliding. Earthquake activity can exacerbate this hazard. The 1906 San Francisco earthquake set off dozens of large landslides in the Santa Cruz Mountains, some of which claimed human lives.

Capitola’s topography ranges in steepness from 0 percent slope (flat) to more than 50 percent slope. The majority of the City falls into a relatively flat category. The primary area of concern for the City of Capitola with regard to landslides is the land above Soquel Creek and below Wharf Road. Exhibit 15 - *Topographic Relief* categorizes the City of Capitola and surrounding areas based on the percentage of slope. Areas on the map most susceptible to landslides and mudflows have slopes greater than 50% and are colored red. The majority of these areas are coastal bluffs, escarpments of decomposed rock or soil resulting from erosion or faulting, with a vertical elevation of at least ten feet. In addition to the coastal bluffs, there are areas along Soquel Creek, Nobel Gulch, and Tannery Gulch that have steep slopes that could be susceptible to landslides and mudflows.

Coastal bluff areas within Capitola that have steep topography include Cliff Drive and surrounding open space, residential areas in the City's Jewel Box neighborhood, as well as shoreline residences and open space areas of the Depot Hill neighborhood, between the Village and New Brighton State Park.

Past Occurrences

Table 32: Landslides and Mudflows identifies past landslide and mudflow events in Santa Cruz County from 2005 through 2011. No major landslides or mudflows have occurred in Capitola.

Table 32: **Landslides and Mudflows**

Date	Location	Magnitude	County-wide Property Damage
3/22/2005	Valencia Road in Aptos	Mudflow	$150,000
3/22/2005	Scotts Valley	Landslide	$375,000
3/22/2005	Santa Cruz County	Landslide	$1,000,000
10/13/2009	Highway 84	Landslide	$10,000
12/19/2010	Old San Jose Road	Mudflow	$4,000

National Climatic Data Center http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwevent~storms

In addition to the past landslide and mudflow events listed above, coastal storms can contribute to landslide and mudflow. Historical events describing coastal storms of this nature can be found in the flood profile.

Probability of Future Occurrence

Although nature caused landslides are beyond control, most recent landslides in the Santa Cruz Mountains have been caused by a combination of human activity and natural factors. Human activities that may destabilize slopes include logging, woodland conversion, road building, housing construction and any activity which alters normal drainage patterns. Whether or not any of these activities will trigger landslides depends on the existing natural conditions. Some soil and rock types are more prone to land sliding than others. In Capitola, areas of greatest concern are located within drainage courses like Soquel Creek, Noble Gulch, and Tannery Gulch. Landslides within these drainages could occur in areas of steep topography, if conditions allow.

Climate Change Considerations

Anticipating that precipitation regimes may change in the future as a result of climate change, there may be greater opportunity for landslides and mudflows. Current climate change science indicates that storms may become less frequent and more intense, which could result in greater amounts of runoff at higher velocities within the various drainages in Capitola. With greater amounts of precipitation underlying soils and rock units could become saturated quicker increasing the risk for landslides. In addition, if water runoff is occurring at greater velocities, there is greater potential for erosion, which could induce landslides and mudflows within Capitola.

Vulnerability/Risk Assessment

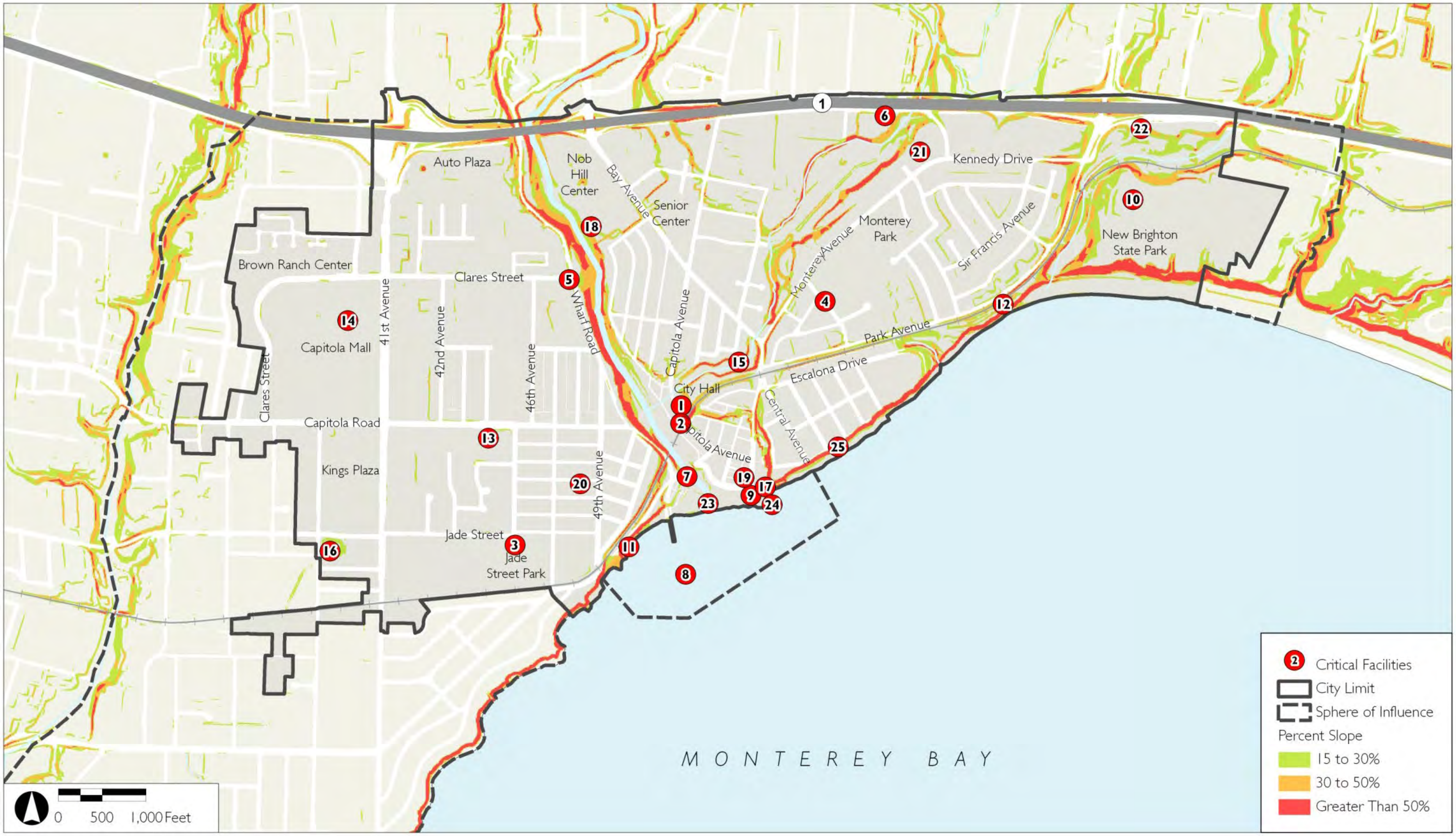
Table 33: Topographic Relief Associated with Capitola Critical Facilities identifies the critical facilities located within the increasing slope categories identified on Exhibit 15: Topographic Relief. The greater the slope, the more

susceptible the area is to a landslide or mudflow. The replacement, contents, and potential loss values have been calculated for each facility located in a sloped area. As stated above, the greater the slope, the more susceptible the area is to a landslide or mudflow.

Map #	Facility	Topographic Relief (Slope)				Replacement Value	Contents Value
		0-15%(no color)	15-30% (green)	30-50% (orange)	>50% (red)		
1	City Hall/Emergency Operations Center	X	X	X	X	$8,000,000	$750,000
1	Capitola Police Station	X	X	X	X	$4,000,000	$750,000
2	Central Fire Station #4	X				$3,000,000	$100,000
3	Jade Street Community Center -- Emergency Shelter	X				$3,000,000	$200,000
4	New Brighton Gym -- Emergency Shelter	X				$2,500,000	$75,000
4	New Brighton School -- Back-up Emergency Shelter	X				$4,000,000	$700,000
5	Capitola Library -- Backup Emergency Operations Center	X				$10,000,000	$700,000
6	Capitola Corporation Yard	X				$2,000,000	$500,000
7	Stockton Avenue Bridge	X	X	X	X	$10,000,000	N/A
9	Capitola Beach Sea Wall	X				$5,000,000	N/A
10	New Brighton State Park--staging area for emergency response	X				N/A	N/A
11	Cliff Drive -at risk arterial (sea wall and road)	X	X	X	X	$8,000,000	N/A
12	Park Avenue-at risk arterial (sea wall and road)	X	X	X	X	$4,000,000	N/A
13	Police Communications Antenna-Capitola Mall	X				$100,000	N/A
14	Police Communications Antenna-AAA Building	X				$100,000	
15	Noble Gulch Storm Pipe	X	X	X	X	$10,000,000	N/A
16	38th Avenue Drainage Facility	X	X			$2,000,000	$300,000

Map #	Facility	Topographic Relief (Slope)				Replacement Value	Contents Value
		0-15%(no color)	15-30% (green)	30-50% (orange)	>50% (red)		
17	Capitola Pump Station-Esplanade Park	X	X	X	X	$10,000,000	$800,000
18	Soquel Pump Station	X	X	X		$10,000,000	$1,700,000
19	Lawn Way Storm Drain Pump Station	X				$500,000	N/A
20	Soquel Creek Water District Treatment Plant, Garnet Street	X				$2,000,000	$700,000
21	Soquel Creek Water District Seawater Intrusion Prevention Well, Monterey Avenue	X				$2,000,000	$70,000
22	SCWD MacGregor Booster Pumping Station	X	X	X		$300,000	N/A
23	Capitola Beach Flume	X				$2,000,000	N/A
24	Capitola Beach Jetty	X				$3,000,000	N/A
25	Grand Avenue Cliffs	X				N/A	N/A
	Total Potential Losses					$115,500,000	$7,345,000

TOPOGRAPHIC RELIEF
EXHIBIT 15



Source: City of Capitola, 2010; Santa Cruz County, 2012.

3.7.3 Expansive Soils

The Technical Advisory Committee initially identified expansive soils as a hazard of risk to the City of Capitola with limited hazard planning consideration. Based on the lack of past occurrences and minimal risk of future impacts from expansive soils, the Hazard Mitigation Planning Team decided not to include a profile for expansive soils. This hazard may be re-visited in future updates to this Plan.

3.8 Summary of Vulnerability

Table 33: Risk Assessment Summary shows a summary of critical facilities that intersect with hazard areas in the City of Capitola. Those facilities that intersect with a hazard area are indicated with a "Y" and a red shaded cell. Facilities that do not fall within the hazard area are designated by an "N" and a green shaded cell. The Capitola Beach Sea Wall and New Brighton State Park were not intersected ("NA") with the liquefaction potential hazard area because they fall outside the hazard area boundary.

As stated above, hazard and critical facility overlays were not conducted for wildfire, windstorm, drought, and earthquake. Overlays were conducted for erosion, flood, hazardous materials, liquefaction, landslide/mudslide, and tsunami. More detailed findings from this analysis can be found in the sections below.

3.9 Significant Hazards

The vulnerability assessments within each hazard profile are used to understand the varying levels of risk to the City of Capitola. Based on these assessments, the planning team concluded the two hazards of greatest concern to the City of Capitola are **coastal storm/flooding** and **tsunami**. For both of these hazards, 12 of the City's 25 critical facilities fall within the 100 year flood zone and the tsunami inundation zone. **Liquefaction** also poses a significant threat to the City. Nine critical facilities fall within the Very High and High liquefaction potential zones, 13 facilities fall within the low liquefaction potential zone, meaning that 22 of the City's 25 critical facilities are at risk to damage caused by liquefaction. **Landslide and mudslide** also pose a risk to the City, with 12 facilities falling within the 30% to greater than 50% slope range.

Table 33: **Risk Assessment Summary**

Facility		Beach Erosion	Cliff Erosion	Flood	Hazardous Materials			Liquefaction Potential				Topo (Slope)				Tsunami
				100 yr.	intersect	within 500'	within 1000'	Very High (A)	High (B)	Low (D)	Undefined (Unkn)	0-15%(no color)	15-30% (green)	30-50% (orange)	>50% (red)	
1	City Hall/Emergency Operations Center	N	N	Y	N	N	N	N	Y	N	N	N	N	N	Y	Y
1	Capitola Police Station	N	N	Y	N	N	N	N	Y	N	N	N	N	N	Y	Y
2	Central Fire Station #4	N	N	Y	N	N	N	N	Y	N	N	Y	N	N	N	Y
3	Jade Street Community Center -- Emergency Shelter	N	N	N	N	N	N	N	N	Y	N	Y	N	N	N	N
4	New Brighton Gym Emergency Shelter	N	N	N	N	N	N	N	N	Y	N	Y	N	N	N	N
4	New Brighton School Backup Emergency Shelter	N	N	N	N	N	N	N	N	Y	N	Y	N	N	N	N

Table 33: **Risk Assessment Summary**

Facility				Flood	Hazardous Materials			Liquefaction Potential				Topo (Slope)				
		Beach Erosion	Cliff Erosion	100 yr.	intersect	within 500'	within 1000'	Very High (A)	High (B)	Low (D)	Undefined (Unkn)	0-15%(no color)	15-30% (green)	30-50% (orange)	>50% (red)	Tsunami
5	Capitola Library Backup Emergency Operations Center	N	N	N	N	N	N	N	N	Y	N	Y	N	N	N	N
6	Capitola Corporation Yard	N	N	N	N	N	N	N	N	Y	N	Y	N	N	N	N
7	Stockton Avenue Bridge	Y	N	Y	N	N	N	Y	N	N	N	Y	Y	Y	Y	Y
8	Capitola Wharf	N	N	Y	N	N	N	NA	NA	NA	NA	N	N	N	N	Y
9	Capitola Beach Sea Wall	N	N	Y	N	N	N	Y	N	N	N	Y	N	N	N	Y
10	New Brighton State Park--staging area for emergency response	N	N	N	N	N	N	NA	NA	NA	NA	Y	N	N	N	N
11	Cliff Drive -at risk arterial (sea wall and road)	N	Y	N	N	N	N	N	N	Y	N	Y	Y	Y	Y	Y

Table 33: **Risk Assessment Summary**

Facility				Flood	Hazardous Materials			Liquefaction Potential				Topo (Slope)				
		Beach Erosion	Cliff Erosion	100 yr.	intersect	within 500'	within 1000'	Very High (A)	High (B)	Low (D)	Undefined (Unkn)	0-15%(no color)	15-30% (green)	30-50% (orange)	>50% (red)	Tsunami
12	Park Avenue-at risk arterial (sea wall and road)	N	Y	N	N	N	N	N	N	Y	N	Y	Y	Y	Y	N
13	Police Communications Antenna-Capitola Mall	N	N	N	N	N	N	N	N	Y	N	Y	N	N	N	N
14	Police Communications Antenna-AAA Building	N	N	N	N	Y	Y	N	N	Y	N	Y	N	N	N	N
15	Noble Gulch Storm Pipe	N	N	Y	N	N	N	N	Y	N	N	Y	Y	Y	Y	Y
16	38th Avenue Drainage Facility	N	N	N	N	N	Y	N	N	Y	N	Y	Y	N	N	N
17	Capitola Pump Station-Esplanade Park	N	Y	Y	Y	N	N	YY	N	N	Y	Y	Y	Y	Y	Y
18	Soquel Pump Station	N	N	Y	N	N	Y	Y	N	N	N	Y	Y	Y	N	N

Table 33: **Risk Assessment Summary**

Facility		Beach Erosion	Cliff Erosion	Flood	Hazardous Materials			Liquefaction Potential				Topo (Slope)				Tsunami
				100 yr.	intersect	within 500'	within 1000'	Very High (A)	High (B)	Low (D)	Undefined (Unkn)	0-15%(no color)	15-30% (green)	30-50% (orange)	>50% (red)	
19	Lawn Way Storm Drain Pump Station	Y	N	Y	N	N	N	Y	N	N	N	Y	N	N	N	Y
20	Soquel Creek Water District Treatment Plant, Garnet Street	N	N	N	N	N	N	N	N	Y	N	Y	N	N	N	N
21	Soquel Creek Water District Seawater Intrusion Prevention Well, Monterey Avenue	N	N	N	N	N	N	N	N	Y	N	Y	N	N	N	N
22	Soquel Creek Water District MacGregor Booster Pumping Station	N	N	N	N	N	N	N	N	Y	N	Y	Y	Y	N	N
23	Capitola Beach Flume	N	N	Y	N	N	N	Y	N	N	N	Y	N	N	N	Y

Table 33: **Risk Assessment Summary**

Facility		Beach Erosion	Cliff Erosion	Flood	Hazardous Materials			Liquefaction Potential				Topo (Slope)				Tsunami
				100 yr.	intersect	within 500'	within 1000'	Very High (A)	High (B)	Low (D)	Undefined (Unkn)	0-15%(no color)	15-30% (green)	30-50% (orange)	>50% (red)	
24	Capitola Beach Jetty	N	N	Y	N	N	N	N	N	N	Y	Y	N	N	N	Y
25	Grand Avenue Cliffs	N	Y	N	N	N	N	N	N	N	Y	Y	N	N	N	N

Y denotes that the critical facility intersects the hazard layer	N denotes that the critical facility does not intersect the hazard layer	NA denotes that the hazard layer is not available within the geographic extent of the analysis

3.10 Facilities at Most Risk

The critical facilities listed in Table 35: Capitola Critical Facilities At Risk are the most at risk to hazard events in the City of Capitola. They fall within multiple hazard zones making them susceptible to future damage from a variety of potential events.

Table 34: **Capitola Critical Facilities At Risk**

Facility	Erosion	Flood	HAZMAT	Liquefaction	Slope	Tsunami
Stockton Avenue Bridge	Y	Y	N	Y	Y	Y
Capitola Pump Station-Esplanade Park	Y	Y	Y	Y	Y	Y
Cliff Drive	Y	N	N	Y	Y	Y
Noble Gulch Storm Pipe	N	Y	N	Y	Y	Y
Park Avenue	Y	N	N	Y	Y	N
Soquel Pump Station	N	Y	Y	Y	Y	N

3.11 Potential Losses

Table 36: Most Costly Capitola Critical Facilities identifies the critical facilities with the greatest replacement value (combination of building replacement and contents value), in the City of Capitola. Should these facilities be completely destroyed by a hazard event, their replacement will be the most costly compared to other identified critical facilities.

Table 35: **Most Costly Capitola Critical Facilities**

Map #	Facility	Replacement Value
8	Capitola Wharf	$20,000,000
5	Capitola Library -- Backup Emergency Operations Center	$10,000,000
7	Stockton Avenue Bridge	$10,000,000
15	Noble Gulch Storm Pipe	$10,000,000
17	Capitola Sewage Pump Station - Esplanade Park	$10,000,000
18	Soquel Sewage Pump Station	$10,000,000
1	City Hall/Emergency Operations Center	$8,000,000
11	Cliff Drive - at risk arterial (sea wall and road)	$8,000,000
9	Capitola Beach Sea Wall	$5,000,000

Of these facilities, the Stockton Avenue Bridge, Cliff Drive, the Noble Gulch Storm Pipe, and the Soquel Sewage Pump Station are also facilities that are most susceptible to hazard events in the City of Capitola.

4 Chapter Four – Mitigation Actions

Hazard mitigation strategies are used to reduce the hazard impacts on large employment and industrial centers, public infrastructure, and critical facilities. This section of the City of Capitola Hazard Mitigation Plan is derived from an in-depth review of the vulnerabilities and capabilities described in this Plan. Mitigation actions from the Santa Cruz County Hazard Mitigation Plan and City of Santa Cruz Hazard Mitigation Plan were also reviewed so that the City of Capitola can support these actions. Overall, the actions represent Capitola's risk-based approach for reducing and/or eliminating the potential losses as identified in the Vulnerability Assessment section of each Hazard Profile.

4.1 Hazard Mitigation Overview

4.1.1 FEMA'S National Flood Insurance Program

In 1968, the US Congress created the National Flood Insurance Program (NFIP). Participation in the NFIP by a Community is voluntary; however, in order to receive funding from FEMA, a Community is required to participate in the program.

The City of Capitola participates in the NFIP and development in the floodplain is permitted according to Title 15.20 Floodplain District of the Municipal Code. Ordinance No. 970 adopted on May 10, 2012 amended the Title 15.20 floodplain management regulations per FEMA guidance and for consistency with the 2010 updated digital flood insurance rate maps. The ordinance is administered, implemented, and enforced by the City's Building Official as the designated floodplain administrator. The Building Official grants or denies building permits in accord with Title 15.20 Floodplain District of the Municipal Code.

The Community Rating System (CRS) is a voluntary part of the National Flood Insurance Program that seeks to coordinate all flood-related activities, reduce flood losses, facilitate accurate insurance rating, and promote public awareness of flood insurance by creating incentives for a community to go beyond minimum discounts. CRS ratings are on a 10-point scale (from 10 to 1, with 1 being the best rating), with residents of the community who live within FEMA's Special Flood Hazard Areas (SFHA) receiving a 5% reduction in flood insurance rates for every Class improvement in the community's CRS rating. The City of Capitola does not currently participate in the Community Rating System.

Repetitive Loss Properties: According to FEMA, in Capitola there are nine properties with a total of 28-repetitive loss incidents which total $615,891.00 dollars (avg. $21,996 per incident).

4.1.2 Hazard Mitigation Goals

The plan goals, presented in the Mitigation Priorities and Goals section of Chapter 1, serve as basis for direction to promote sound public policy designed to protect citizens, critical facilities, infrastructure, private property, and the environment from hazards. The Plan goals guide the direction of future activities aimed at reducing risk and preventing loss from natural hazards. The goals also serve as checkpoints as agencies and organizations begin implementing mitigation action items.

The hazard mitigation actions identified below list those activities which the City of Capitola will utilize to reduce their risk to potential hazards. These mitigation actions were identified through data collection and research, collaboration with the Technical Advisory Committee, and public input. Mitigation actions as related to coastal climate change vulnerability as derived in part from the Coastal Climate Change Vulnerability Report, June 2017, which is included as part of this LHMP update and included as Appendix C.

Some of these actions may be eligible for funding through Federal and State grant programs, and other funding sources as made available to the City. The mitigation actions are intended to address the comprehensive range of identified hazards. Some actions may address risk reduction from multiple hazards.

4.1.3 Hazard Mitigation Prioritization

Through discussion and self-analysis, the TAC used the STAPLE/E (Social, Technical, Administrative, Political, Legal, Economic, and Environmental) criteria, as described in Table 36: STAPLE/E Review and Selection Criteria, when considering and prioritizing the most appropriate mitigation alternatives for the City. This methodology (as endorsed by FEMA) requires that social, technical, administrative, political, legal, economic, and environmental considerations be taken into account when reviewing potential actions to undertake. This process was used to help ensure that the most equitable and feasible actions would be undertaken based on the City's unique capabilities.

To develop a consensus priority ranking for the mitigation actions, each representative at the third milestone meeting was given ten votes to identify their highest priority mitigation actions. The votes were tallied to identify the highest priority mitigation actions and results incorporated into the final mitigation action priority rankings.

Table 36: **STAPLE/E Review and Selection Criteria**

Social
• Is the proposed action socially acceptable to the jurisdiction and surrounding community? • Are there equity issues involved that would mean that one segment of the jurisdiction and/or community is treated unfairly? • Will the action cause social disruption?
Technical
• Will the proposed action work? • Will it create more problems than it solves? • Does it solve a problem or only a symptom? • Is it the most useful action in light of other jurisdiction goals?
Administrative
• Can the jurisdiction implement the action? • Is there someone to coordinate and lead the effort? • Is there sufficient funding, staff, and technical support available? • Are there ongoing administrative requirements that need to be met?
Political
• Is the action politically acceptable? • Is there public support both to implement and to maintain the project?

Table 36: **STAPLE/E Review and Selection Criteria**

Legal
• Is the jurisdiction authorized to implement the proposed action? • Are there legal side effects? Could the activity be construed as a taking? • Will the jurisdiction be liable for action or lack of action? • Will the activity be challenged?
Economic
• What are the costs and benefits of this action? • Do the benefits exceed the costs? • Are initial, maintenance, and administrative costs taken into account? • Has funding been secured for the proposed action? If not, what are the potential funding sources (public, non-profit, and private)? • How will this action affect the fiscal capability of the jurisdiction? • What burden will this action place on the tax base or local economy? • What are the budget and revenue effects of this activity? • Does the action contribute to other jurisdiction goals? • What benefits will the action provide?
Environmental
• How will the action affect the environment? • Will the action need environmental regulatory approvals? • Will it meet local and state regulatory requirements? • Are endangered or threatened species likely to be affected?

4.1.4 Hazard Mitigation Benefit-Cost Review

FEMA requires local governments to analyze the benefits and costs of a range of mitigation actions that can reduce the effects of each hazard within their community. Benefit-cost analysis is used in hazard mitigation to show if the benefits to life and property protected through mitigation efforts exceed the cost of the mitigation activity. Conducting benefit/cost analysis for a mitigation activity can assist communities in determining whether a project is worth undertaking now, in order to avoid disaster related damages later. The analysis is based on calculating the frequency and severity of a hazard, avoided future damages, and risk.

A hazard mitigation plan must demonstrate that a process was employed that emphasized a review of benefits and costs when prioritizing the mitigation actions. The benefit-cost review must be comprehensive to the extent that it can evaluate the monetary as well as the non-monetary benefits and costs associated with each action. The benefit-cost review should at least consider the following questions:

- How many people will benefit from the action?
- How large an area is impacted?

- How critical are the facilities that benefit from the action (which is more beneficial to protect, the fire station or the administrative building)?
- Environmentally, does it make sense to do this project for the overall community?

For the Capitola LHMP, the Technical Advisory Committee used these questions to determine the appropriateness of mitigation actions. Those actions that did not have adequate benefits were excluded from the preliminary list of mitigation actions.

4.2 Hazard Mitigation Actions

The process used to identify hazard mitigation actions for this Plan included the following:

- Review of the Risk Assessment presented in Chapter 3 of this plan;
- Review of the Capabilities Assessment presented in Chapter 5 of this plan;
- Review of the Santa Cruz County and City of Santa Cruz Hazard Mitigation Plan mitigation actions;
- Review of new concerns/ issues that need to be addressed to reduce hazards to critical facilities.

Table 37: Capitola Hazard Mitigation Actions identifies the primary hazard, mitigation action priority, proposed mitigation action, City department responsible for implementation, the anticipated funding source(s), and the target completion date.

Potential Funding Source(s) identified in the table include the following:

PDM	Pre-Disaster Mitigation (FEMA)
HMGP	Hazard Mitigation Grant Program (FEMA)
CDBG	Community Development Block Grant (CA Department of Housing & Community Development)
FMA	Flood Mitigation Assistance (FEMA)
FHA	Federal Highway Administration
CalEMA	CalOES
Caltrans	California Department of Transportation

Table 37: **Capitola Hazard Mitigation Actions**

Mitigation Action	Responsible Department	Potential Funding Source(s)	Target Completion Date	Priority	Status Since 2013 LHMP
1. Earthquake / Liquefaction Hazard Related Actions					
A. Continue to enforce the requirements of the Geologic Hazards District (Chapter 17.48) of the Capitola Municipal Code which requires the assessment of geologic hazards by a registered geologist or professional engineer for all new development projects. The geologic hazards identified through this assessment process are then mitigated by avoidance or through measures designed by civil engineers using the California Building Code.	Community Development, Public Works, and Building	Staff budget, Review Fees, Development Impact Fees	Ongoing	Low	Unchanged
B. Continue to enforce the most current versions of both the California Building Code (CBC) and the California Building Standards with regards to seismicity, including requiring engineering and liquefaction studies for all potentially affected development.	Public Works and Building	Staff budget	Ongoing	Low	Unchanged

Table 37: **Capitola Hazard Mitigation Actions**

Mitigation Action	Responsible Department	Potential Funding Source(s)	Target Completion Date	Priority	Status Since 2013 LHMP
C. In cooperation with other agencies, conduct seismic evaluations of all City owned critical facilities (including roadways, water, sewer, storm drains and emergency use facilities) and coordinate with other agencies to evaluate non-city owned critical facilities. Seek funding sources to assist in necessary upgrades of these critical facilities.	Public Works and Other Agencies	PDM, HMGP, Staff budget, and General Fund	2025	Low	Unchanged
D. Work with Caltrans and other relevant agencies to evaluate and retrofit the structural integrity of all bridges to ensure their safety during a seismic event.	Public Works	PDM, HMGP, Staff budget	2030	Low	Unchanged
E. Continue training appropriate plan check staff on seismic requirements for new and existing structures.	Building	Staff budget	Ongoing	Low	Unchanged
2. Coastal Storm / Flooding Hazard Related Actions					
A. Evaluate the likelihood of debris flow impacts to the Stockton Avenue bridge during a catastrophic flooding event.	Public Works	FHA, FMA, Staff budget	2017	High	Completed
B. Improve the Noble Gulch storm drain facilities to protect against flooding within the Capitola Village.	Public Works and Community Development	PDM, HMGP, General Fund	2025	High	Unchanged

Table 37: **Capitola Hazard Mitigation Actions**

Mitigation Action	Responsible Department	Potential Funding Source(s)	Target Completion Date	Priority	Status Since 2013 LHMP
C. Relocate or elevate critical facilities (e.g. City hall, police, fire, etc.) above the level of the 100-year flood elevation.	Public Works and Community Development	PDM, HMGP, General Fund	2035	High	Unchanged
D. Continue to implement the Soquel Creek Lagoon Management Plan.	Public Works and Community Development	PDM, HMGP, FMA, Staff budget	Ongoing	Medium	Unchanged
E. Participate in the National Weather Service (NWS) Storm Ready Program	Community Development and Public Works	Staff budget, General Fund	Ongoing	Medium	Unchanged
F. Assist in the planning and/or improvement of infrastructure (e.g. sewers) and facilities to help minimize flooding impacts, particularly in critical flood-prone areas (e.g. Capitola Village).	Public Works and Community Development in coordination with the County Sanitation District	FHA, PDM	Ongoing	Low	Unchanged
G. Continually monitor and review CA State Water Resources Control Board regulations and permit requirements to ensure consistency with city policies and regulations. This includes on-site retention of stormwater runoff from impervious surfaces and the implementation of Low Impact Development (LIDs) standards on new development.	Public Works and Community Development	Staff budget	Ongoing	Low	Unchanged

Table 37: **Capitola Hazard Mitigation Actions**

Mitigation Action	Responsible Department	Potential Funding Source(s)	Target Completion Date	Priority	Status Since 2013 LHMP
H. Limit development and monitor conditions of development and grading permits to prevent sedimentation in natural channels and wetlands.	Community Development	Staff budget	Ongoing	Low	Unchanged
I. Develop more accurate GIS maps of the City's drainage system in coordination with future updates of the Capitola Stormwater Management Program.	Public Works and Community Development	CalEMA, General Fund, Staff budget	2025	Low	Unchanged
J. In coordination with the Santa Cruz County Public Works & Flood Control & Water Conservation District (Zone 5), evaluate the effectiveness of current policies and ordinances to ensure that storm water runoff from impervious surfaces does not contribute to flooding.	Public Works and Community Development	Staff budget	2025	Low	Unchanged
K. Continually monitor and review FEMA's National Flood Insurance Program (NFIP) requirements to ensure the City's floodplain management regulations are in compliance.	Public Works and Community Development	Staff budget	Ongoing	Low	Unchanged
L. Participate in the FEMA NFIP Community Rating System (CRS).	Community Development	Staff budget	2025	Low	Unchanged

Table 37: **Capitola Hazard Mitigation Actions**

Mitigation Action	Responsible Department	Potential Funding Source(s)	Target Completion Date	Priority	Status Since 2013 LHMP
M. Work in coordination with the Santa Cruz County Public Works & Flood Control & Water Conservation District (Zone 5) to develop and disseminate public education materials on flood protection and mitigation by working collaboratively with community groups, non-governmental organizations and the local media.	Community Development	General Fund	Ongoing	Low	Unchanged
N. Review and update the city's existing ordinances as they relate to storm / flooding hazards, consistent with the risks identified in this LHMP.	Community Development	Staff budget, PDM, HMGP, General Fund	2025	Low	Unchanged
O. Adopt policies to limit municipal capital improvements that would be at risk.	Public Works and Community Development	Staff budget, General Fund	2030	Low	Unchanged
P. Improve resiliency to flooding along Soquel Creek and Coast such as the construction of flood walls and improved building guidelines (increase free board and first floor parking).	Public Works and Community Development	PDM, HMGP, CDBG, CalEMA, FMA	2050	Low	New
Q. Investigate natural habitat buffering to reduce coastal flooding such as beach and kelp management.	Public Works and Community Development	HMGP	2030	Low	New

Table 37: **Capitola Hazard Mitigation Actions**

Mitigation Action	Responsible Department	Potential Funding Source(s)	Target Completion Date	Priority	Status Since 2013 LHMP
R. Upgrade vulnerable storm drains with tidal flap gates and pumps, as appropriate.	Public Works	PDM, HMGP, FMA, CalEMA, General Fund	2030	Low	New
S. Investigate various opportunities for beach nourishment and replenishment in concert with rebuilding the City's groin located at the east end of the main beach.	Public Works	PDM, HMGP	2020	Medium	New
T. Prepare a coastal bluff and beach management plan for Capitola that outlines short- and long-term coastal bluff management strategies that will help to establish local protection and adaptation priorities.	Public Works and Community Development	PDM, HMGP, CDBG, General Fund	2030	Medium	New
U. Prioritize coastal protection structures for upgrade and replacement including the sea wall along The Esplanade and coastal revetments.	Public Works	PDM, HMGP, CDBG, General Fund	2040	Low	New
V. Consider resiliency improvements to protect and maintain critical vehicular and non-vehicular coastal access ways.	Public Works and Community Development	PDM, HMGP, CDBG, General Fund	2030	Medium	New
W. Adopt policies to limit municipal capital improvements that would be at risk.	Public Works and Community Development	Staff budget, General Fund	2025	Medium	New

Table 37: **Capitola Hazard Mitigation Actions**

Mitigation Action	Responsible Department	Potential Funding Source(s)	Target Completion Date	Priority	Status Since 2013 LHMP
X. Improve resiliency to flooding along Soquel Creek including the possibility of a temporary or permanent flood wall along the Soquel Creek walking path may help to reduce flooding within high risk areas.	Public Works and Community Development	PDM, HMGP, FMA, CalEMA	2050	Low	New
Y. Identify priority areas for future protection accounting for costs, structural feasibility and secondary implications (flood wall, seawall or revetment).	Public Works and Community Development	PDM, HMGP, FMA, CalEMA; Staff budget; General Fund	2060	Low	New
Z. Investigate long-term options to manage sea level rise and coastal erosion such as living shorelines, soft armoring techniques, and relocation of development within coastal hazard zones. As part of this investigation, consider the preparation of a comprehensive, long-term proactive management plan to protect Depot Hill in a way that preserves the natural coastline and avoids hard armoring.	Public Works and Community Development	PDM, HMGP, FMA, CalEMA; Staff budget; General Fund	2060	Low	New
3. Drought Hazard Related Actions					
A. Work in coordination with the City of Santa Cruz and the Soquel Creek Water District to implement water conservation strategies that maximize the use of existing water resources.	Community Development	Staff budget	Ongoing	Low	Unchanged

Table 37: **Capitola Hazard Mitigation Actions**

Mitigation Action	Responsible Department	Potential Funding Source(s)	Target Completion Date	Priority	Status Since 2013 LHMP
B. Work in coordination with the Soquel Creek Water District to construct and implement the Pure Water Soquel, Groundwater Replenishment and Seawater Intrusion Prevention Project	Public Works	Staff budget, Prop 84 – IRWMP	2022	High	Unchanged
C. Coordinate with the Soquel Creek Water District and City of Santa Cruz to inform public of water conservation restrictions and drought conditions.	Community Development	Staff budget	Ongoing	Low	Unchanged
4. Windstorm Hazard Related Actions					
A. Coordinate with Pacific Gas & Electric to implement an ongoing tree trimming program for trees located in close proximity to overhead power lines.	Public Works	Staff budget, PG&E	Ongoing	Low	Unchanged
B. Establish a working relationship with the NWS Decision Support program to be advised of upcoming weather conditions in a manner that enables smart decisions.	Police Department	Staff budget	2025	Low	Unchanged

Table 37: **Capitola Hazard Mitigation Actions**

Mitigation Action	Responsible Department	Potential Funding Source(s)	Target Completion Date	Priority	Status Since 2013 LHMP
5. Coastal Erosion/ Bluff Failure Hazard Related Actions					
A. Work in close coordination with state and local agencies and organizations to protect and preserve the coastline and its coastal bluffs through restoration efforts to help ensure safe coastal access and the protection of adjacent infrastructure and facilities. These efforts may include beach replenishment, coastal bluff protection, seawall construction, and other appropriate measures.	Public Works, Community Development, County Sanitation District	Staff budget	Ongoing	Medium	Unchanged
6. Tsunami Hazard Related Actions					
A. Continue implementation of Tsunami Ready Program	Community Development, Public Works, Police	Staff budget	Ongoing	Medium	Unchanged
B. Maintain a public communication system to warn the public of a potential tsunami threat.	Community Development, Public Works, Police	Staff budget	Ongoing	Medium	Unchanged
C. Support the timely and accurate update of tsunami inundation maps within the Monterey Bay area. Then integrate the new tsunami inundation maps into the risk assessment of this Local Hazard Mitigation Plan	Community Development, Public Works, Police	Staff budget	Ongoing	Low	Unchanged

Table 37: **Capitola Hazard Mitigation Actions**

Mitigation Action	Responsible Department	Potential Funding Source(s)	Target Completion Date	Priority	Status Since 2013 LHMP
D. Continue to work collaboratively with relevant agencies and organizations to investigate tsunami threat to the City based on the best available information.	Community Development, Public Works, Police	Staff budget	Ongoing	Low	Unchanged
7. Hazardous Materials Related Actions					
A. Continue to coordinate with the Santa Cruz County Department of Environmental Health Services, on enforcement of State and local statutes and regulations pertaining to hazardous materials/ waste storage, use, and disposal.	Community Development, Public Works, Police, Fire	Staff budget	Ongoing	Low	Unchanged
B. Support staff training and education requirements regarding emergency response procedures associated with transportation-based hazardous materials releases.	Community Development, Public Works, Police, Fire	Staff budget	Ongoing	Low	Unchanged
C. Continue to coordinate the Urban Area Security Initiative to enhance preparedness efforts.	Police	UASI, Homeland Security Grant	Ongoing	Not Ranked*	Unchanged

Table 37: **Capitola Hazard Mitigation Actions**

Mitigation Action	Responsible Department	Potential Funding Source(s)	Target Completion Date	Priority	Status Since 2013 LHMP
8. Fire Hazard Related Actions					
A. Coordinate with the Fire District and Department of Corrections to create fuel reduction zones near properties at risk, shaded fuel breaks, and clean up areas prone to ground fuel litter common with invasive species habitat (i.e. Eucalyptus)	Fire, Public Works	Staff Budget	Ongoing	Not Ranked*	Unchanged
B. Continue to maintain cooperative fire protection and fire prevention agreements with the Central Fire Protection District and other relevant agencies.	Community Development, Public Works, Police, Fire	Staff budget	Ongoing	Low	Unchanged
C. Identify inadequate access roadways. Develop a program to address inadequacies.	Community Development, Public Works, Fire, Police	PDM, HMGP, General Fund	Ongoing2025	Low	Unchanged
D. Promote land use planning and implement building codes to reduce incidence of human-caused wildfires especially in very high fire hazard areas.	Community Development, Building, Fire	Staff budget	Ongoing	Low	Unchanged
E. Implement building codes relevant to fire protection in new development or major renovations. (i.e. built-in fire extinguishing and fire alarm systems)	Community Development, Building, Fire	Staff budget	Ongoing	Low	Unchanged

Table 37: **Capitola Hazard Mitigation Actions**

Mitigation Action	Responsible Department	Potential Funding Source(s)	Target Completion Date	Priority	Status Since 2013 LHMP
F. Work cooperatively with Central Fire Protection District, CalFire, and other relevant agencies to promote the implementation and awareness of fire prevention programs.	Community Development, Fire	Staff budget	Ongoing	Low	Unchanged
9. Landslide/ Mudflow Hazard Related Actions					
A. Continue to require that geologic/engineering reports be prepared for any proposed construction near landsliding and require mitigation of landslide hazards before issuing any building or grading permits.	Community Development, Building, Public Works	Staff budget	Ongoing	Low	Unchanged
10. Multi-Hazard Related Actions					
B. Coordinate hazard mitigation progress/efforts with the Santa Cruz County Office of Emergency Services and other agencies and cities within Santa Cruz County.	Community Development, Public Works, Police, Fire, City Manager	Staff budget	Ongoing	Medium	Unchanged
C. Continue to work with Santa Cruz 911 and other relevant agencies to maintain a coordinated and effective emergency communication system.	Community Development, Public Works, Police, Fire	Staff budget	Ongoing	Low	Unchanged

Table 37: **Capitola Hazard Mitigation Actions**

Mitigation Action	Responsible Department	Potential Funding Source(s)	Target Completion Date	Priority	Status Since 2013 LHMP
D. Continue to update and enhance mapping data and the City's GIS for all hazards.	Information Technology	General Fund	Ongoing	Low	Unchanged
E. Verify the replacement value of City-owned critical facilities and coordinate with other agencies for non city-owned facilities to improve the risk assessment within this plan.	Public Works, Community Development, Finance	General Fund	2019	Low	Completed
F. Work with the appropriate cellular phone service providers to ensure there is always adequate cellular services to critical facilities within the City.	Police, Information Technology	Staff budget	Ongoing	Low	Unchanged
G. Reference and integrate the City's Local Hazard Mitigation Plan into the Safety Element of the General Plan.	Community Development	General Fund, DRI	2015	Low	Completed
H. Integrate the results of the Monterey Bay Sea Level Rise Study into the Local Hazard Mitigation Plan risk assessment and the General Plan Safety Element.	Community Development	DRI	2025	Low	New
I. As part of the General Plan Update process, develop a plan to address climate change/ climate adaptation issues within the City and its surroundings.	Community Development	Staff budget	2014	Low	Completed

Table 37: **Capitola Hazard Mitigation Actions**

Mitigation Action	Responsible Department	Potential Funding Source(s)	Target Completion Date	Priority	Status Since 2013 LHMP
J. Protect and preserve the coastline through permit review and continue to review coastal development for conformance with applicable City regulations (e.g. geologic, flood).	Community Development, Public Works	Staff budget	Ongoing	Low	Unchanged
K. Review and update the city's existing ordinances as they relate to hazards and risks identified in this LHMP.	Community Development	Staff budget	2025	Low	Unchanged

*These mitigation actions were added after mitigation action ranking was conducted.

4.3 Capabilities Assessment

This capability assessment is designed to identify existing local agencies, personnel, planning tools, public policy and programs, technology, and funds that have the capability to support hazard mitigation activities and strategies outlined in this LHMP. To create this capability assessment, the Technical Advisory Committee collaborated to identify current local capabilities and mechanisms available to the City of Capitola for reducing damage from future natural hazard events. These plans and resources were reviewed while developing the Local Hazard Mitigation Plan and summarized below.

4.3.1 Key Resources

The City of Capitola and the County of Santa Cruz have several key departments with resources to support the implementation of mitigation actions. These departments offer a variety of planning, technical, policy, and staffing resources as summarized in Table 38: Capitola Capabilities Assessment.

Table 38: **Capitola Capabilities Assessment**

Type of Resource	Resource Name	Ability to Support Mitigation
Community Development Department		
Personnel Resource	Community Development Director	Leads the development and implementation of this Local Hazard Mitigation Plan. Can use personnel resources to include outreach to the public.
Policy Resource	Zoning Ordinance	The Zoning Ordinance is the main tool to implement the City's General Plan. It sets land use regulations and the zoning map for the City. Hazard mitigation related zones include the floodplain district and the geologic hazards district. Mitigation actions outlined in this Plan can be adopted in the form of land use/development regulations.
Policy Resource	Building Code/Fire Code	International Building Code, International Fire Code.
Policy Resource	Code Enforcement	Each zoning district has specific zoning codes and guidelines that were developed to enhance and protect each district. The Community Development Department enforces and carries out these guidelines.
Technical and Personnel Resources	GIS Program	GIS creates an updated zoning map and General Plan map and also maintains an interactive parcel map that residents can use to determine if they are located in a floodplain, floodway, or redevelopment district.

Table 38: **Capitola Capabilities Assessment**

Type of Resource	Resource Name	Ability to Support Mitigation
Plan Resource	General Plan	Principal policy document that guides conservation, development, and change in the City. Identifies City programs and policies as they pertain to land use, public services, housing, natural resources, and safety. Hazard data and mitigation actions described in this Plan have been incorporated into the General Plan. Capitola's General Plan was adopted 2014. The City can adopt the 2020 LHMP into the Safety Element of the General Plan
Policy Resource	Housing Program	The City offers numerous programs to help residents maintain safe housing.
Plan Resource	Flood Management Plan	The City manages floodplain per Chapter 17.50 Floodplain Management of the Capitola Municipal Code.
Personnel Resource	Planning Commission	The Planning Commission meets once per month to discuss planning capabilities in Capitola. They review and comment on the LHMP.
Plan Resource	2007 Economic Development Strategic Plan	The underlying belief of the Economic Development Strategy is that the local economy interlinks with many other aspects of a community, including housing, transportation, recreation, and safety. This document helps understand economic development trends in Capitola.
Plan Resource	Existing Conditions White Papers	Provide background information on City of Capitola.
Plan and Technical Resource	Local Coastal Program Land Use Plan	Land Use maps will be revised as part of the LCP update which is currently underway. Planning and IT departments may update the General Plan maps, as relevant, to address mitigation identified in this LHMP.
Plan Resource	2005 Historic Structures List	Provides a list of historic structures in Capitola.
Plan Resource	Climate Action Plan	Completed 2015.
Building Department		
Personnel Resource	Building Official	Enforces building codes and development ordinances including the floodplain management ordinance. New and updated building codes can address hazards as addressed in this LHMP.
Policy Resource	Inspections & Permit	Building permits ensure that zoning requirements as well as fire and structural safety standards are met.
City Council		
Policy Resource	Policy Approval	Policy legislation and implementation

Table 38: **Capitola Capabilities Assessment**

Type of Resource	Resource Name	Ability to Support Mitigation
City Administration		
Administrative / Personnel Resource	City Manager	Supports the development and implementation of this Local Hazard Mitigation Plan by allocating the appropriate personnel and resources.
Financial Resource	Finance	Budgeting and Risk Management for City owned facilities. Money for the local match for FEMA mitigation funding are available from the City of Capitola General Fund.
Public Works Department		
Personnel Resource	Public Works Director	Participates in the development and implementation of this Hazard Mitigation Plan.
Technical and Policy Resource	Streets Program	Provides maintenance and improvement of the City's streets and highways. Also provides maintenance of Soquel Creek, Capitola Lagoon, City owned buildings, and the municipal wharf.
Policy and Plan Resource	Storm Water Management Program	The Depot Hill Drainage Study was conducted in 2008 and the Storm Water Management Program is updated annually.
Policy and Plan Resource	Capital Improvement Program	The Capital Improvement Program should be informed by the strategies identified and prioritized in this plan.
Personnel Resource	Grant writing	Part of the Engineering Department
Police Department		
Training and Personnel Resource	Police Chief	Coordinates preparedness training, public outreach on safety and emergency preparedness, and emergency response.
Policy and Plan Resource	Emergency Preparedness	Includes emergency preparedness guides for the elderly, physically challenged, and children.
Special Districts		
Central Fire Protection District of Santa Cruz County		
Personnel Resource	Fire Chief	Coordinates emergency response, fire prevention education, CERT training, and wildfire education and prevention.
Plan Resource	Wildland Fire Structure Protection Plan	A western portion of the City limits (where there is a large stand of Eucalyptus trees) is located in the Central Fire Districts Wildland Protection Zone CTL 11.
Plan Resource	Central Fire District Master and Strategic Plan	This Plan can assist the City in identifying future improvements and prioritize mitigation activities.

Table 38: **Capitola Capabilities Assessment**

Type of Resource	Resource Name	Ability to Support Mitigation
Personnel Resource	Emergency Services	Coordinates with City staff on emergency preparedness, response, and mitigation activities.
Policy Resource	Public Education Program and CERT Training	Educates City employees and residents on hazards awareness, prevention, and preparedness.
Policy Resource	Commercial Building Inspections and Permits	The Fire District provides reoccurring fire prevention inspections of all commercial buildings in the City. The District also provides plan check and permit functions for commercial development addressing Fire Code Standards.
Soquel Creek Water District		
Plan Resource	Urban Water Management Plan and Pure Water Soquel Project	Identifies adequate water supplies and proper planning, funding, and construction of future water infrastructure improvements.
Plan Resource	Emergency Response Plan (ERP)	The goals of the ERP are to rapidly restore water service after an emergency, ensure adequate water supply for fire suppression, minimize water system damage, minimize impact and loss to customers, minimize negative impacts on public health and employee safety, and provide emergency public information concerning customer service.
Plan Resource	Groundwater Management Plan	Enhances existing water supplies and identifies future opportunities for planning and funding of groundwater management activities.
Soquel Union Elementary School District		
Personnel and Technical Resource	New Brighton School	The School District owns and manages the New Brighton Middle School which is the City's back-up Emergency shelter location, which is co-located with the New Brighton Gym (the city-owned primary emergency shelter.)
911 Communications Center		
Technical Resource	Santa Cruz Regional 911	Provides a means of notification to residents and listed phone numbers during an emergency situation allowing resident and businesses to relocate out of a potentially vulnerable area.
City of Santa Cruz Water District		
Plan and Personnel Resource	Wildfire Preparedness	Links to various wildfire educational websites. Personnel can develop and outreach program to inform the public that these website exist.

Table 38: **Capitola Capabilities Assessment**

Type of Resource	Resource Name	Ability to Support Mitigation
Plan Resource	Urban Water Management Plan	A long range planning document to aid in updating city and county General Plans and for preparation of environmental documents under the California Environmental Quality Act. Serves as a detailed source of information to coordinate local water supply availability and certain land use decisions made by cities and counties.
Plan Resource	Water Supply Assessment	Assesses the adequacy of the water supply to meet the demand of proposed projects over the next 20 years in addition to the public water system's existing and planned future uses.
Plan Resource	Adequacy of Municipal Water Supplies to Support Future Development	Provides information on the ability of the system to deliver water and offers possible approaches that could be used by policy makers to integrate local land use decisions with long-term water supply availability.
Plan Resource	Water Shortage Contingency Plan	Establishes procedures and actions that can be taken to respond to a large, long term shortage in the water supply.
Plan Resource	City of Santa Cruz/Soquel Creek Water District Evaluation of Regional Water Supply Alternative	Provides an evaluation of "regional" desalination and wastewater reclamation facilities to augment water supplies for both the City and the District.
Santa Cruz County		
Technical Resource	County Flood Control and Water Conservation District (5)	Provides flood protection and regulation and stormwater services for Zone 5 facilities.
Technical Resource	County Sanitation District	Operates water and wastewater services.
Technical Resource	County Public Works	Assist the City in protecting the public's health, safety, and welfare through superior engineering, maintenance, operations, and administrative services that incorporate customer service and integrity with competence and productivity for a sustained commitment to excellence.
Plan Resource	San Mateo-Santa Cruz Community Wildfire Protection Plan	Identifies wildfire hazard areas and methods for reduction/ elimination of fire hazards.

Table 38: **Capitola Capabilities Assessment**

Type of Resource	Resource Name	Ability to Support Mitigation
Plan Resource	Hazard Mitigation Plan	Identifies mitigation actions for County of Santa Cruz critical facilities.
Plan Resource	Coastal Incident Response Plan	Establishes response framework and protocols for incidents along the Santa Cruz County coastline, including the City of Capitola.
Plan Resource	Operational Area Emergency Management Plan (2005)	Overall emergency management plan for the Santa Cruz County Operational Area.
Plan Resource	Tsunami Response Plan Annex (2010)	The City of Capitola relies on the Tsunami Response Plan Annex developed to accompany the Operational Area Emergency Management Plan.
Plan Resource	General Plan	Provides policies within Santa Cruz County intended to reduce hazards and disasters.
Plan Resource	Emergency Preparedness Guide	Provides a resource for residents/ businesses to better prepare for future disaster/ emergency situations.
Policy Resource	Growth Management	Reduces development potential within hazard prone areas.
Technical Resource	Rain and Stream Gauging	Allow the City to better monitor rainfall and stream flow totals to gauge the adequacy of storm drain infrastructure capacity.
Technical and Staffing Resource	NIMS Training	On an ongoing basis, County OES conducts training for all department heads on their role in an emergency based on the National Incident Management Systems (NIMS). This training proved to be successful in the response to the severe floods in March 2011.
Technical Resource	National Weather Service	Decision Support Program (improved forecast interpretations for making informed decisions)
Technical Resource	CalOES	Hazard Mitigation Web Portal provides guidance and examples of hazard mitigation planning as well as notifications regarding available funding.
Technical Resource	Federal Emergency Management Agency	Guidance for hazard mitigation planning processes and resources.

4.3.2 Fiscal Capability

City of Capitola Budget Department Overview

The following summarizes Capitola's fiscal capabilities in terms of the City's financial resources and allocated spending. Sales tax and property tax are the primary sources of Capitola's financial resources. The City has allocated the majority of these financial resources to Public Safety, Community Development, Public Works, and City Manager/City Clerk/Human Resources departments which are all relevant for implementing hazard mitigation actions.

The City Council, City Manager, Community Development, Police, and Public Works departments all have a general fund that could be used toward mitigation activities. These departments also have budgets used to employ City staff that are an integral part of the mitigation planning process. These staff members include:

- The City Manager's department employs an Information Systems Specialist.
- The Community Development Department staff includes a community development director, one planner, and a building inspector and official.
- Public Works Department staff includes a public works director and a ten person maintenance crew.
- The Police Department employees a chief, captain, sergeant, and 16 police officers. This department is also responsible for the City's Emergency Preparedness.

Capital Improvement Projects: 2020-2022

Capital improvements projects scheduled for the 2020-21 fiscal year include several projects that include hazard mitigation elements. Three specific projects to rehabilitate the Capitola wharf, beach jetty and flume address sea level rise, costal storm damage, and climate change. The flume and jetty project, scheduled for Fall of 2020, will rehabilitate these structures to their designed specifications. The wharf project, currently in environmental review and permitting, will increase the storm resiliency of the structure while providing for future raising of the wharf deck to further address sea level rise. The water project is currently on schedule to begin construction in 2021.

5 Chapter Five - Plan Maintenance Process

This Chapter identifies the formal process that will ensure that the Capitola LHMP (the Plan) remains an active and relevant document. The Plan maintenance process includes a schedule for monitoring and evaluating the Plan annually and producing an update every five years.

This chapter describes how Capitola will integrate public participation throughout the plan maintenance and implementation process. It also describes how the City intends to incorporate the mitigation actions outlined in this Plan into existing planning mechanisms and programs. These include the Capitola General Plan, the City's Capital Improvement Program, as well as building code enforcement and implementation. The Plan's format allows the City to readily update sections when new data becomes available, resulting in a Plan that will remain current and relevant to the City of Capitola.

5.1 Monitoring, Evaluating and Updating the Plan

5.1.1 Coordinating Body

The Capitola Hazard Mitigation Planning Team will be responsible for the maintenance of this LHMP. The City of Capitola Community Development Department will take the lead in LHMP maintenance issues, by coordinating maintenance of this Plan and undertaking the formal review process and the rewrite of the LHMP.

5.1.2 Convener

The City of Capitola Community Development Department will facilitate the Hazard Mitigation Planning Team meetings, and will assign tasks such as updating and presenting the Plan to other Departments, Stakeholder Groups, and/or elected officials. Plan implementation and evaluation will be a shared responsibility among all of the Hazard Planning Team.

5.1.3 Evaluation

The minimum task of the ongoing annual hazard mitigation planning team meeting will be the evaluation of the progress of the Plan and incorporating the actions into other planning documents. This review will include the following:

- Summary of any hazard events that occurred during the prior year and their impact on the community.
- Review of successful mitigation initiatives identified in the Plan.
- Brief discussion about why targeted mitigation strategies were not completed.
- Re-evaluation of the mitigation actions plan to determine if the timeline for identified projects needs to be amended (such as changing a long-term project to a short-term project due to funding availability).
- Recommendations for new mitigation actions.
- Changes in, or potential for, new funding options/grant opportunities.
- Integration of new GIS data and maps that can be used to inform the Plan.
- Evaluation of any other planning programs or initiatives within the City that involve hazard mitigation.

The City will create a template to guide the LHMP team in preparing a progress report. The City will also prepare a formal annual report on the progress of the LHMP. This report will be used as follows:

- Distributed to City department heads for review.
- Provided to the local media through a press release.
- Presented in the form of a council report to the City Council.

5.2 Method and Schedule for Updating the Plan within 5 years

Section 201.6.(d)(3) of Title 44 of the Code of Federal Regulations requires that local hazard mitigation plans be reviewed, revised if appropriate, and resubmitted for approval in order to remain eligible for benefits awarded under the Disaster Mitigation Act (DMA). The City intends to update the Plan on a five-year cycle from the date of initial plan adoption. It is anticipated that this update process will occur one year prior to expiration of the existing plan. This cycle may be accelerated to less than five years based on the following triggers:

- A Presidential Disaster Declaration that impacts the City of Capitola.
- A hazard event that causes loss of life.

The intent of the update process will be to add new planning process methods, community profile data, hazard data and events, vulnerability analyses, mitigation actions and goals to the adopted plan so that the Plan will always be current and up to date. Based on the needs identified by the planning team, the update will, at a minimum, include the elements below:

1. The update process will be convened through a committee appointed by the Community Development Director and will consist of at least one member of the General Plan Update Advisory Committee or staff to ensure consistency between Plans.
2. The hazard risk assessment will be reviewed and updated using best available information and technologies on an annual basis.
3. The evaluation of critical structures and mapping will be updated and improved as funding becomes available.
4. The mitigation actions will be reviewed and revised to account for any actions completed, deferred, or changed to account for changes in the risk assessment or new City policies identified under other planning mechanisms, as appropriate (such as the General Plan).
5. The draft update will be sent to appropriate agencies for comment.
6. The public will be given an opportunity to comment prior to adoption.
7. The Capitola City Council will adopt the updated Plan.

5.3 Adoption

The Capitola City Council is responsible for adopting the Plan. This formal adoption should take place every five years. Once the Plan has been adopted, the City of Capitola Community Development Department will be responsible for final submission to the Governor's Office of Emergency Services (CalOES). CalOES will then submit the Plan to the Federal Emergency Management Agency (FEMA) for final review and approval.

5.4 Implementation through Existing Programs

The effectiveness of the City's non-regulatory LHMP depends on the implementation of the Plan and incorporation of the outlined mitigation action items into existing City plans, policies, and programs. The Plan includes a range of action items that, if implemented, would reduce loss from hazard events in the City. Together, the mitigation action items in the Plan provide the framework for activities that the City can choose to implement over the next five years. The City has prioritized the plan's goals and identified actions that will be implemented (resources permitting) through existing plans, policies, and programs.

The Community Development Department has taken on the responsibility for overseeing the Plan's implementation and maintenance through the City's existing programs. The Community Development Director, or designated appointee, will assume lead responsibility for facilitating LHMP implementation and maintenance meetings. Although the Community Development Department will have primary responsibility for review, coordination, and promotion, plan implementation and evaluation will be a shared responsibility among all departments identified as lead departments in the mitigation action plan. The Community Development Department will continue to work closely with the Santa Cruz County Emergency Operations Manager to insure consistency with all relevant plans.

5.5 Incorporation into Existing Planning Mechanisms

The following planning mechanisms from the 2013 LHMP were implemented:

- Capitola Building Codes
- Monterey Bay Sea Level Rise studies (various)

The following planning mechanisms were not implemented:

- Santa Cruz County Emergency Management Plan
- Capitola Capital Improvement Program
- Capitola Storm Water Management Program
- Capitola Emergency Operations Plan

The information on hazards, risk, vulnerability, and mitigation contained in this Plan is based on the best information and technology available at the time the LHMP was prepared. As previously stated, the City's General Plan is considered to be an integral part of this plan. The City, through adoption of its 1994 General Plan (Safety Element) goals, has planned for the impact of natural hazards. The City's General Plan is currently being updated and the LHMP process has allowed the City to review and expand upon the policies contained within the General Plan Safety Element. The City views the General Plan and the LHMP as complimentary planning documents that work together to achieve the ultimate goal of the reduction of risk exposure to the citizens of Capitola. Many of the ongoing recommendations identified in the mitigation strategy are programs recommended by the General Plan and other adopted plans. The City will coordinate the recommendations of the LHMP with other planning processes and programs including the following:

5.6 Continued Public Involvement

The public will continue to be apprised of the LHMP actions through the City website and by providing copies of the annual progress report to the media. Copies of the Plan will be distributed to the Santa Cruz Library System. Upon initiation of the LHMP update process, a new public involvement strategy will be developed based on guidance from the planning team. This strategy will be based on the needs and capabilities of the City at the time of the update. At a minimum, this strategy will include the use of local media outlets within the planning area and the City's website.

5.7 Point of Contact

Steve Jesberg
City of Capitola
City of Capitola Public Works Director
831/475-7300

Local Hazard Mitigation Plan

Appendices

2020

Appendix A – **Timeline of Capitola Natural Hazard Events**

Prepared by Carolyn Swift, Former Museum Director, City of Capitola

Timeline of Natural Hazard Events Impacting the City of Capitola

DATE	TYPE	IMPACT/PROPERTY DAMAGE	IMAGES
1791-1792	Flood	Santa Cruz Mission destroyed	
1847	Flood	Sawmill constructed on Soquel Creek (Rancho Soquel) destroyed. It had been built by John Hames and John Daubenbiss, who later obtained lands of the Rancho Rodeo, and became the founders of the town of Soquel (1852).	
1852	Flood	This was a major flood event but impact not recorded (no newspapers had yet been established).	
1/9/1857	Earthquake	Three earthquakes struck the Santa Cruz vicinity in a series. The tower and a portion of the Santa Cruz Mission Church collapsed.	
Jan. 1862	Storm/Flood	Major event—Soquel village inundated; mills, flumes, school, town hall, houses and barns were destroyed. Massive pile of debris went out to sea and then washed ashore at Soquel Landing.	
8/01/1863	Earthquake	Described as “severe shock.”	
1863-64	Drought	Unknown	
10/08/1865	Earthquake	Unknown	
11/25/1865	Storm/High Tide	500 feet of the Soquel Landing wharf is lost; the remaining 600 feet are deemed “useless.” Nearby barn blown down. Two young whales and a hair cloth sofa washed ashore. Waves described as “mountain high.” Wharf damage is $6,000. Pilings are deposited in a potato field beyond the beach.	

Timeline of Natural Hazard Events Impacting the City of Capitola

DATE	TYPE	IMPACT/PROPERTY DAMAGE	IMAGES
12/14/1867	Storm	Wharves damaged in Aptos and Watsonville but no specifics are listed for Soquel Landing.	
9/19/1868	"Tidal Wave"	High tide described as tidal wave; damage unknown	
10/24/1868	Earthquake	"Second only to October 1865"	
2/03/1869	Storm, flood, slides, washouts	New bridge washed away at Soquel; roads impassable.	
12/23/1871	Southeast gale, flood, high tide	Water gauged to be "higher than flood of 1862."	
1/24/1874	Storm	Roaring surf. Rain threatens crops.	
12/04/1875	Flood	Compared to ferocity of the 1862 flood	
1877	Severe drought	Capitola's founder, S.A. Hall, was boarding 300 horses at his stable during the summer. The price of hay went to $20.00 a ton due to the drought, and he lost money. When landowner F.A. Hihn increased the rent two years later, Hall couldn't afford the increase, and left.	

Timeline of Natural Hazard Events Impacting the City of Capitola

DATE	TYPE	IMPACT/PROPERTY DAMAGE	IMAGES
1/19/1878	Storm with tide	No Capitola impact recorded.	
7/01/1882	Earthquake	Worst since 1868	
1/30/1881	Storm	Conflicting reports on damage to Capitola. One report describes the resort as destroyed, while another stated damage was "not as serious."	
March 1883	Earthquake	Severe shock with several aftershocks recorded. No damage listed for Capitola.	
3/10/1884	Flooding and Washouts	Storm lasted five days. No Capitola impact described in newspapers	
12/16/1886	High surf	Capitola impact unknown	
12/30/1886	High surf	High seas; ships prevented from landing	
5/10/1887	Heaviest surf of the season	No damage reported for Capitola.	
9/18/1888	Earthquake	Described as extremely severe.	
1/05/1889	Storm	Damage to beach areas	
12/26/1889	Storm	Train service stopped; Santa Cruz County becomes isolated.	
1/06/1890	Storm/ Mudslides in mountains	Worst winter in 40 years; concern for grain crops	

Timeline of Natural Hazard Events Impacting the City of Capitola

DATE	TYPE	IMPACT/PROPERTY DAMAGE	IMAGES
1/27/1890	Floods	Judged to be as bad as 1852, 1862, and 1871; Capitola floods, footbridge and span of wagon bridge destroyed. Esplanade flooded—buildings to be replaced in "permanent form." A huge pile of debris appears along the beach.	
2/08/1892	High tides	Yacht "Petrel" washed ashore at Capitola; beachfront concessions damaged. Swimmers endangered.	
1/12/1899	Severe storm	Several days duration; damage unknown	
1/02/1900	Storm	Severe; no damage listed.	
3/14/1905	Storm	Judged to be "worst in 27 years." Capitola impact unknown.	
1/20/1906	Flood	Buildings from Loma Prieta Lumber Company camp above Soquel are destroyed. Debris at Capitola. Downtown Soquel floods. Landslides in hills.	

Timeline of Natural Hazard Events Impacting the City of Capitola

DATE	TYPE	IMPACT/PROPERTY DAMAGE	IMAGES
1906, 5:12am	Earthquake	Nine men killed in mudslide at the Loma Prieta mill above Soquel; surge on local creeks; water pipes broken, chimneys and walls cracked. Splits in the earth. Magnitude 8.3.	
4/27/1907	Storm	High water and flooding; Capitola damage unknown	
1/21/1911	Storm	Unknown	
3/07/1911	Storm	Unknown	
1911	Erosion	Incidents of cliff erosion along Grand Avenue prompt Lewis B. Hanchett, the owner of El Salto Resort, to begin chopping down trees on what is left of "Lover's Lane" along the bluff of Depot Hill. Hanchett believed that when the trees fell, they further hastened the cliff erosion.	 

DATE	TYPE	IMPACT/PROPERTY DAMAGE	IMAGES
11/27/1913	Storm and tide	Great groundswells when the tide was highest. Waves ran across the beach to the Esplanade and water spread "clear to the railroad tracks." Union Traction Company tracks covered with sand. Water reached the Hihn Superintendent's Building (Capitola and Monterey Avenues), and waves were described as "monster." About 200 feet of wharf washed away. Stranded fisherman rescued and pulled underwater to safety. A huge pile of debris covered the beach and was cut-up for firewood. Fisherman Alberto Gibelli stranded when mid-section of wharf washed away.	 
1/01/1914	Flood	Flood in Soquel and along Soquel Creek.	
11/28/1919	Storm	Damage high; no Capitola details	
12/27/1921	Storm	Described as "great."	

DATE	TYPE	IMPACT/PROPERTY DAMAGE	IMAGES
2/12 and 2/13/1926	High tides	Waves to 20 feet. Wharf damaged. Sea wall promenade broken at Venetian Courts. Apartments flooded. Breakers slammed into Esplanade, destroying boathouse/bathhouse, beach concessions. Tide hits the second floor of Hotel Capitola. Water runs a foot deep through village.	  

DATE	TYPE	IMPACT/PROPERTY DAMAGE	IMAGES
		Top photo courtesy of Homer Berry	  

Timeline of Natural Hazard Events Impacting the City of Capitola

DATE	TYPE	IMPACT/PROPERTY DAMAGE	IMAGES
10/28/1926	Earthquake	Damage recorded in Capitola	
1/24/1930	Erosion	About 130 residents appear before Santa Cruz County Supervisors to protest announced firing of 12-inch guns at Camp McQuaide, Capitola. Among petitioners claims are that "the terrific jar of the guns loosens the rim of the cliffs, and the earth is sloughing off to a dangerous degree."	
1928-1937	Drought	Reported as one of longest and most severe in state's history. Capitola is bordered by bulb ranches and floral nurseries, as well as poultry ranches and rabbit farms.	
12/26/1931	Storm	Soquel Creek rises; cleans lagoon at Capitola. Debris and wood deposited on the beach.	
12/28 and 12/29/1931	Storm and high tide	Damage to cottages and concessions at New Brighton Beach. Roads fill with "the muck of the sea." At Seacliff Beach, the concrete ship Palo Alto is shaken loose and moved about three feet as if "impelled by the spirit of the sea to fulfill its destiny and start moving." Soquel "River" widens to sixty feet, the highest since 1890, damaging property in Soquel and all the way to the mouth at Capitola. Orchards are lost with the rapid rise of water. Hundreds gather to watch the tides batter the concessions at the beach. There is a "vortex of water where the river and sea meet." The waterfront is piled high with flood debris thrown back up the beach.	*Photo courtesy of Lee Lester* 

Timeline of Natural Hazard Events Impacting the City of Capitola

DATE	TYPE	IMPACT/PROPERTY DAMAGE	IMAGES
		The creek cuts across the beach and moves sand below the new outlet. Two months later, workers discovered a noticeable settling of the western end of the bathhouse, due to a break in the retaining wall. This left a portion of the bathhouse supported only by its concrete flooring. Repairs required rebuilding the retaining wall and replacing the fill.	
1/04/1935	Flood	Capitola Village floods; thirty feet of the sea wall is taken out. Beach playground disappears. Venetian Courts hit hard but damage minimal.	*Photo courtesy of Lee Lester*
1/09/1935	Erosion	Near the seawall cave-in by the site of the old hotel, a tree fell sixty feet from Grand Avenue. The "new favorite outdoor sport" for onlookers is to walk behind the sewer plant to see the fallen tree and debris of the broken sea wall.	
12/14/1936	Drought	Long drought ended by rain.	
2/14/1937	Flood	Soquel Creek floods in Soquel Village due to logjam at the bridge on Soquel Drive. Landslides in watershed.	
3/22-23/1937	Storm	Boats in the streets at Capitola. An estimated $3,000 is spent to repair the sea wall at the Venetian Court Apartments.	
2/10/1938	Storm winds	Winds up to 70 mph; 500 trees uprooted throughout county. Thunderous seas lashed the waterfront from Aptos to Capitola.	

DATE	TYPE	IMPACT/PROPERTY DAMAGE	IMAGES
1/04/1939, 10:30pm	Wind and waves	Main damage to Capitola Beach Club at the Esplanade and Monterey Avenue. Water and sand carried into the structure and spread out over the dance floor to the bandstand. While the storm was still raging, thieves jimmied the back door of the club's tap room, and made away with two slot machines, along with the stands on which they had rested. Ocean also swept over the Esplanade during the night, and into town for a block-and-a-half, carrying sand and rocks, some 6-8 inches in diameter. Waves hit the front and sides of the pier. Sand and rocks were swept into lower terraces of the Venetian Court and covered porches of the casino on the waterfront, but did no serious damage.	
1/8/1940, 9pm-Noon	Storm	The "old Capitola casino" owned by Capitola Amusement Company was the principal victim of storm. Casino "capsized" shortly after 9 a.m. Plans for new structure announced immediately.	

DATE	TYPE	IMPACT/PROPERTY DAMAGE	IMAGES
		Photo courtesy of Homer Berry	 
1/12/1940	Storm	Most rain “since 1890” reported.	
1/26/1940	Storm	“Shatters all records.”	
2/27/1940	Severe Flood	Logs pile against bridge in downtown Soquel and village floods. Landslides in watershed.	

Timeline of Natural Hazard Events Impacting the City of Capitola

DATE	TYPE	IMPACT/PROPERTY DAMAGE	IMAGES
3/31/1940	Storm	"Wettest day in Santa Cruz history."	
12/23/1940	Storm	Flood conditions, winds	
2/09/1941	Near record storm		
4/2/1941	Severe Storm	Lasting many days Damage unknown	
4/15/1941	Earthquake	Santa Cruz is epicenter. No damage.	
6/02/1941	Earthquake	Sharp jolt	
6/18/1941		Capitola announces plans to lengthen flume	
12/09/1943	Gale winds	60-mile-an-hour winds create damage in county	
2/5/1945	Flood conditions	Local damage unknown	
April 1946	Tsunami	Earthquake in Aleutians produced 115-foot wave. Tsunami observed along the West Coast. A man was swept to sea in Santa Cruz. Ten-foot waves hit the coastline.	
1947-1949	Drought	Statewide	
8/01/1949	"Heaviest surf in 20 years"	18-foot waves recorded along the coast. Swimmer drowns in Santa Cruz.	

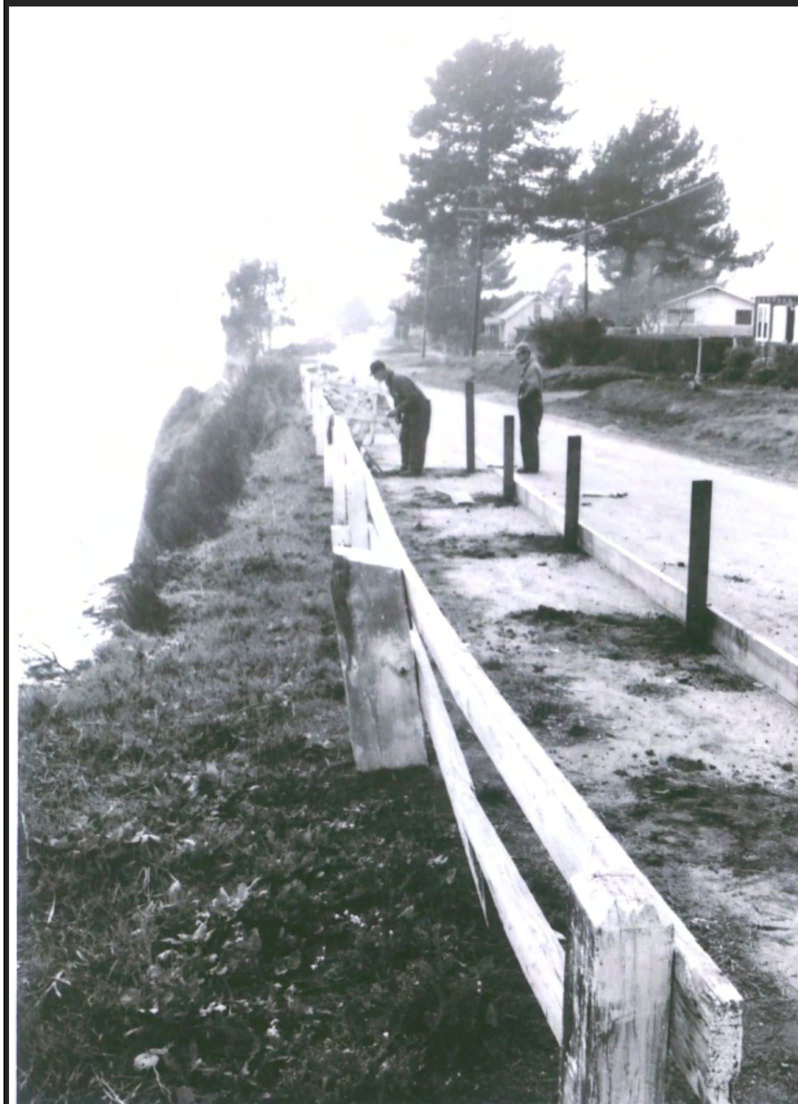
Timeline of Natural Hazard Events Impacting the City of Capitola

DATE	TYPE	IMPACT/PROPERTY DAMAGE	IMAGES
Winter 1953	Giant swells	Ocean side of building at the end of the Capitola Wharf smashed in by waves 20-30 feet at high tide. Six pilings broken off.	 

Prov[illegible] of Capitola Historical

DATE	TYPE	IMPACT/PROPERTY DAMAGE	IMAGES
4/15/1954	Earthquake	Falling plaster, broken chimneys, shattered dishes	
12/22/1955	Highest Flood	At the Soquel Drive bridge in downtown Soquel, remains of a four-room house and five cabins joined the rubble that wedged against the bridge abutments, causing the bridge to collapse. Overall damage to property in Soquel and Capitola exceeded $1 million. Capitola damage included the Venetian Courts. Noble Creek and Tannery Creek also flooded. *Photos courtesy of Carolyn Swift*	 

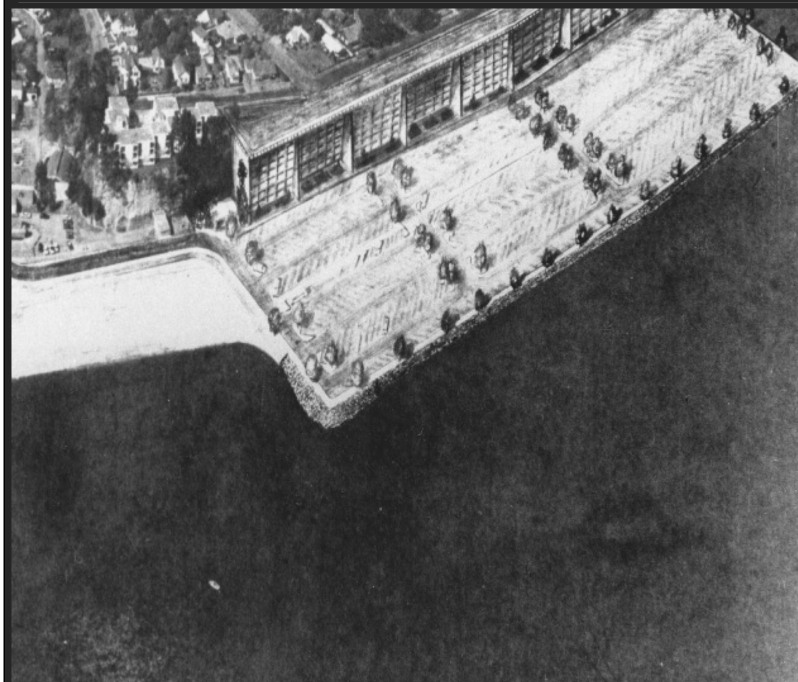
DATE	TYPE	IMPACT/PROPERTY DAMAGE	IMAGES
5/2/1955	Erosion	Sentinel: Capitola City Council Asks Cleanup Help "Believe it or not, a few people still occasionally throw garbage over the cliff, particularly along Grand Avenue. This not only creates health hazards, but also attracts rodents which burrow into and weaken the cliff, increasing the rate of cliff erosion…." *Photos courtesy of Covello and Covello Photography.*	 
4/3/1958	High Tide	Esplanade smashed by tides. Andy Antonetti's Merry-go-round damaged; horses are knocked off and washed down San Jose Avenue. *Photo courtesy of Covello and Covello Photography.*	

DATE	TYPE	IMPACT/PROPERTY DAMAGE	IMAGES
2/09/1960	Gale winds, heavy seas	Power outages, slides, and winds 35-40 mph. Capitola hardest hit. Damage estimated at $100,000. Ten Venetian Court apartments flooded. "A sign was ripped off the end of the wharf, rolled into a ball, and deposited into an apartment." Heavy waves smashed the beach restaurants, amusement concessions, and the merry-go-round. Rocks and logs strewn across the beach. Water pushed back under the Stockton Bridge, crushing the riverfront fences 100 yards on either side. An estimated $5,000 in damage was done to the wharf building, but not much happened to the wharf itself. Cliffs crumbled on Grand Avenue. Police Chief Marty Bergthold called it "The worst storm in 15 years." A portion of Grand Avenue falls into the ocean.' *15 people knocked to the ground by breakers. One woman injured.*	
Summer 1961	Birds fall from sky	Sooty Shearwaters fall from the sky; they are affected by toxins from red algae. Birds cover streets, wharf, and beach. Alfred Hitchcock inspired to move ahead with filming "The Birds."	

Timeline of Natural Hazard Events Impacting the City of Capitola

DATE	TYPE	IMPACT/PROPERTY DAMAGE	IMAGES
1963	Erosion	Capitola City Council votes to start condemnation proceedings against Harry Hooper to obtain 320 feet of Hooper Beach for erosion control to protect Cliff Drive, where a high rise development was planned.	
1963	Erosion	Capitola City Council considers construction of seawall to control erosion from Grand Avenue to New Brighton Beach. The filled in area would also provide parking for approximately 400 cars.	
Dec. 20, 1964	Erosion	Construction begins on controversial Crest "prestige" 24-unit apartment house on the bay side of Grand Avenue on Depot Hill. Robert Lamberson, architect. Grand Avenue residents eventually sue the City over a disputed 10-foot setback for the project, which was built on a former park site at the top of the bluff. *Cost $500,000.* In the 1980s, several units facing the bay were removed due to cliff erosion. *Photo courtesy of Minna Hertel.*	
12/20/1964	Flood threat	Storm and tide alarms City with a disappearing beach	

Timeline of Natural Hazard Events Impacting the City of Capitola

DATE	TYPE	IMPACT/PROPERTY DAMAGE	IMAGES
1/13/1965	Erosion	Capitola considers feasibility study to build 370-foot seawall along Grand Avenue. Backfilling below Grand Avenue would be used for a 1,000-car parking lot. Developers expressed desire to lease portion of the parking lot for a three-story, 20 unit convention hotel with restaurant and cocktail bar, to be built along the Grand Avenue bluff. First step was to have the beach deeded to the city by the state. *$1,228,000 estimated cost for parking lot* *$275,000 estimated cost for hotel.* *Photo courtesy of Covello and Covello Photography.*	
Summer 1965	Erosion	Capitola requests help from the State Department of Water Resources to solve the problem of disappearing sand, due to "failure of Santa Cruz harbor officials to install a recommended sand by-pass at the harbor jetty. *Photo courtesy of Al Lowry.*	

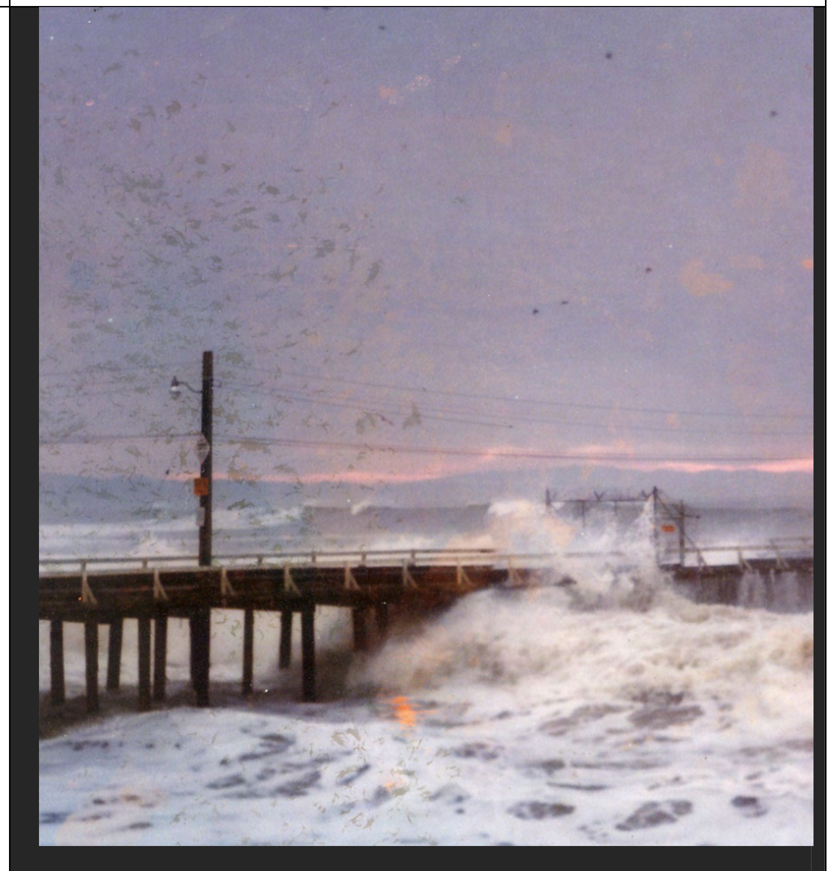
Timeline of Natural Hazard Events Impacting the City of Capitola

DATE	TYPE	IMPACT/PROPERTY DAMAGE	IMAGES
Summer of 1965	Erosion	Off-Shore parking lot plan revised. Parking lot to extend 430 feet out into the way from the cliffs south of Capitola beach for about 1,500 feet. A breakwater is planned to extend 600 feet south to the end of the high cliff area, to prevent cliff erosion. The parking lot would also be used as an "overnight parking unit" with commercial concessions for tourists. Project to cover ten acres reclaimed from the bay. *Photo courtesy of Covello and Covello Photography.*	
December 1965	Storm	The City replaced 21 pilings under the wharf that were weakened by the storm. Capitola officials fear that waves would smash the seawall which protected sewer lines that ran from Capitola's pumping station to the East Cliff Sanitation District plant. That winter, the county public works department offered 500 cubic feet of rock rubble to be placed against the seawall.	

Timeline of Natural Hazard Events Impacting the City of Capitola

DATE	TYPE	IMPACT/PROPERTY DAMAGE	IMAGES
1966	Erosion	Lifelong resident Violet Gooch hired Granite Construction to build a rip-rap wall at the base of the cliff at the end of the row of homes west of the wharf. (Hooper Beach) *Photo courtesy of Covello and Covello Photography.*	
January 1967	Storm	Reported as heavy	
1968	Erosion	Army Corps of Engineers begins work to construct a groin, completed the following spring. *Cost $160,000.*	
January 1973	Storm	Beach littered with tons of driftwood after heavy rains.	
1975	Wind storm	40 knot winds downed trees and power lines.	
1976-77	Severe drought	Water conservation ordered	

Timeline of Natural Hazard Events Impacting the City of Capitola

DATE	TYPE	IMPACT/PROPERTY DAMAGE	IMAGES
1976	Strong winds	Winds downed power lines	
12/21/1976	High waves	Waves crash over wharf	
10/2/1979	High waves	At least eight sailboats were destroyed at Capitola during the morning. A powerful swell broke 15 boats from their moorings off the Capitola Wharf. The boats were pushed ashore by 12-to-20 foot waves that pounded the shoreline.	
Jan 1980	Flood	No damage reported	

Timeline of Natural Hazard Events Impacting the City of Capitola

DATE	TYPE	IMPACT/PROPERTY DAMAGE	IMAGES
1/16/1980	Earthquake	Epicenter of 3.6 magnitude quake in Corralitos	

Timeline of Natural Hazard Events Impacting the City of Capitola

DATE	TYPE	IMPACT/PROPERTY DAMAGE	IMAGES
January 3-5, 1982	Flood	Torrential rainfall, floods, mudslides countywide. Soquel Creek overflowed and flooded Soquel. The logjam at the bridge was estimated to be nearly 100 yards wide and 25 feet high. In Capitola, damage was comparatively minimal. The roadway leading to the Stockton Avenue bridge was damaged. The bridge bulkhead was undercut. Several of the Venetian Court units were damaged and a portion of the seawall gave way. *City officials estimated damage to public property at $270,889.*	  

Timeline of Natural Hazard Events Impacting the City of Capitola

DATE	TYPE	IMPACT/PROPERTY DAMAGE	IMAGES
12/17/1982	Storm	Restaurant on the newly renovated Capitola Wharf is damaged in storm.	
1/27/1983	High Tide	Capitola Wharf buildings, the Venetian Courts, the former boathouse building (Mr. Toots Downstairs) and all other business of the Esplanade were flooded. Water extends down San Jose Avenue and Lawn Way. Huge logs and debris are scattered through town. The giant surf took out a 30-foot section of the wharf which had been renovated in 1982. *Photos courtesy of Minna Hertel.*	 

DATE	TYPE	IMPACT/PROPERTY DAMAGE	IMAGES
		Top photo courtesy of Minna Hertel; middle photo courtesy of Sandy Lydon.	
2/10/1983	High Tide	Surf rolls over the sea wall along the Esplanade. Water and debris extend as far as Capitola Avenue. *(Photo courtesy of Minna Hertel)*	

DATE	TYPE	IMPACT/PROPERTY DAMAGE	IMAGES
			
3/1/1983	High Tide/strong winds	Waves damaged the restaurant at the end of the wharf, crashed over beach wall and entered restaurants on the Esplanade, "but damage was nothing compared to the million-dollar loss suffered in January," said Capitola City Manager Steve Burrell.	
2/15/1984	Erosion	Even though planner Susan Tupper warned the plan might not be a lasting solution, Capitola City Council approved a plan to stabilize its crumbling cliffs by installing artificial seaweed—a series of floating plastic fronds anchored to a sand-filled tube. The intent was to capture sand that drifts down the coast each year, thereby building a sandy beach in front of the cliffs below Grand Avenue. The "ersatz" seaweed lasted until the next major storm and then drifted to sea. *Cost $120,000.* The cliff continues to erode at a rate of 12-18 feet per year.	

Timeline of Natural Hazard Events Impacting the City of Capitola

DATE	TYPE	IMPACT/PROPERTY DAMAGE	IMAGES
1987-1992	Drought	Severe drought, water conservation ordered.	
10/17/1989, 5:04pm, Duration of 15 Seconds	Earthquake	Loma Prieta 6.9 mag earthquake with epicenter 3 miles north of Aptos. Comparatively, damage to Capitola homes and businesses was not as severe. Within the city, no buildings damaged and no one was injured physically. *Damage countywide ultimately estimated to be about $1 billion.* *(Top photo courtesy of Karen Nevis)*	 
March 1995	Flood	The creek rose near the village.	

Timeline of Natural Hazard Events Impacting the City of Capitola

DATE	TYPE	IMPACT/PROPERTY DAMAGE	IMAGES
Winter 1996	Flood	Yards and basements of homes along both sides of Soquel Creek near the village were flooded.	
2007-2009	Drought	Water waste regulations strictly enforced; voluntary 15% conservation savings requested by local water providers.	
Winter 2008	High tide	Old bathhouse/boathouse building (Margaritaville/Stockton Bridge Grill) battered by swells. *(Photo courtesy of Karen Nevis)*	

Timeline of Natural Hazard Events Impacting the City of Capitola

DATE	TYPE	IMPACT/PROPERTY DAMAGE	IMAGES
3/11/2011	Tsunami	Capitola Village received warnings, but no damage	
March 24 and 26, 2011	Noble Creek and Tannery Creek Floods	Noble Creek floods village; Tannery Creek rushes through New Brighton Parking lot and undermines the cliff roadway.	 

Timeline of Natural Hazard Events Impacting the City of Capitola

DATE	TYPE	IMPACT/PROPERTY DAMAGE	IMAGES
			 

Timeline of Natural Hazard Events Impacting the City of Capitola

DATE	TYPE	IMPACT/PROPERTY DAMAGE	IMAGES
			 

Appendix B – **Detailed Critical Facilities Inventory**

Critical Facilities Inventory

Facility ID	Facility	Year Built	Type of Structure	Replacement Value	Contents Value	Occupancy	Facility Address
1	City Hall/Emergency Operations Center	1975	Government	$8,000,000	$750,000	30	420 Capitola Ave
1	Capitola Police Station	1975	Government	$4,000,000	$750,000	30	422 Capitola Ave
2	Central Fire Station #4		Government	$3,000,000	$100,000	20	405 Capitola Ave
3	Jade Street Community Center - Emergency Shelter and Police Antenna	1978	Government	$3,000,000	$200,000	varies	4500 Jade Street
4	New Brighton Gym and Performing Arts Center-- Emergency Shelter	1980	Government	$2,500,000	$75,000	varies	300 Washburn Ave
4	New Brighton School Performing Arts Center- Back-up Emergency Shelter	2010	Education	$4,000,000	$700,000	varies	300 Washburn Ave
5	Capitola Library -- Backup Emergency Operations Center	1990	Government	$10,000,000	$700,000	20	2005 Wharf Road
6	Capitola Corporation Yard	1980	Government	$2,000,000	$500,000		430 Kennedy Dr
7	Stockton Avenue Bridge	1934	Government	$10,000,000	N/A	N/A	N/A
8	Capitola Wharf	1986	Government	$20,000,000	$300,000	N/A	1400 Wharf Rd
9	Capitola Beach Sea Wall	late 80's	Government	$5,000,000	N/A	N/A	Capitola Beach
10	New Brighton State Park - staging area for emergency response	N/A	Government	N/A	N/A	N/A	McGregor Drive
11	Cliff Drive - at risk arterial (sea wall and road)	N/A	Government	$8,000,000	N/A	N/A	Cliff Drive (Wharf Rd to Opal Cliff Dr)
12	Park Avenue - at risk arterial (sea wall and road)	N/A	Government	$4,000,000	N/A	N/A	Park Ave (Weslely St to Coronado Ave)
13	Police Communications Antenna - Capitola Mall		Government	$100,000	N/A	N/A	4400 Capitola Road
14	Police Communications Antenna-AAA Building		Government	$100,000	N/A	N/A	1855 41st Ave
15	Noble Gulch Storm Pipe	1963	Utilities	$10,000,000	N/A	N/A	426 Capitola Ave
16	38th Avenue Drainage Facility		Utilities	$2,000,000	$300,000	N/A	Brommer & 38th
17	Capitola Sewage Pump Station - Esplanade Park	1978	Utilities	$10,000,000	$800,000	N/A	104 Monterey Ave
18	Soquel Sewage Pump Station	1975	Utilities	$10,000,000	$1,700,000	N/A	N/A
19	Lawn Way Storm Drain Pump Station	2002	Utilities	$500,000	N/A	N/A	N/A
20	Soquel Creek Water District Treatment Plant, Garnet Street		Utilities	$2,000,000	$700,000	N/A	4809 Garnet St
21	Soquel Creek Water District Seawater Intrusion Prevention Well, Monterey Avenue		Utilities	$2,000,000	$70,000	N/A	N/A
22	Soquel Creek Water District MacGregor Booster Pumping Station		Utilities	$300,000	N/A	N/A	McGregor Drive
23	Capitola Beach Flume	1940	Government	$2,000,000	N/A	N/A	Capitola Beach
24	Capitola Beach Jetty	1985	Government	$3,000,000	N/A	N/A	Capitola Beach
25	Grand Avenue Cliffs	N/A	N/A	N/A	N/A	N/A	Grand Ave b/w Saxon and Oakland Ave
	Total			**$125,500,000**	**$7,645,000**		

Capitola Local Hazard Mitigation Plan

Critical Facilities Inventory

Facility ID	Facility	Longitude	Latitude	Contact Person	Organization	Contact #	Generator
1	City Hall/Emergency Operations Center	121.57.12	36.58.28	Steve Jesberg	City of Capitola	831-475-7300	No
1	Capitola Police Station	121.57.12	36.58.28	Captain Andrew Dally	City of Capitola	831-475-4242	Yes
2	Central Fire Station #4	121.57.12	36.58.26	Chief Steve Hall	Central Fire Protection District	831-4796842	Yes
3	Jade Street Community Center - Emergency Shelter and Police Antenna	121.27.35	36.58.12	Elise LeGare	City of Capitola	831-475-5935	No
4	New Brighton Gym and Performing Arts Center-- Emergency Shelter	121.26.52	36.58.40	Steve Jesberg	City of Capitola	831-475-7300	No
4	New Brighton School Performing Arts Center- Back-up Emergency Shelter	121.26.52	36.58.40	Paul Rucker	Soquel Union School District	831-464-5639	No
5	Capitola Library -- Backup Emergency Operations Center	121.57.28	36.58.42	Jonell Jel'enedra	City of Capitola/SC Public Libraries	831-427-7705	No
6	Capitola Corporation Yard	121.56.44	36.59.01	Eddie Ray Garcia	City of Capitola	831-476-4227	No
7	Stockton Avenue Bridge	121.57.11	36.58.20	Steve Jesberg	City of Capitola	831-475-7300	No
8	Capitola Wharf	121.57.11	26.59.09	Steve Jesberg	City of Capitola	831-475-7300	No
9	Capitola Beach Sea Wall	121.57.02	36.58.18	Steve Jesberg	City of Capitola	831-475-7300	No
10	New Brighton State Park - staging area for emergency response	121.56.09	36.58.52	Charles Bockman	CA State Parks	831-247-3610	n/a
11	Cliff Drive - at risk arterial (sea wall and road)	121.57.19	36.58.12	Steve Jesberg	City of Capitola	831-475-7300	No
12	Park Avenue - at risk arterial (sea wall and road)	121.56.27	36.58.40	Steve Jesberg	City of Capitola	831-475-7300	No
13	Police Communications Antenna - Capitola Mall	121.57.39	36.58.24	Chief Steve Hall	City of Capitola	831-475-4242	Yes
14	Police Communications Antenna-AAA Building	121.57.59	36.58.37	Chief Steve Hall	City of Capitola	831-475-4242	Yes
15	Noble Gulch Storm Pipe	121.57.12	36.58.28	Steve Jesberg	City of Capitola	831-475-7300	No
16	38th Avenue Drainage Facility	121.58.01	36.58.11	Rachel Fatoohi	County of Santa Cruz	831-454-2160	No
17	Capitola Sewage Pump Station - Esplanade Park	121.57.00	36.58.19	Rachel Lather	SC County Sanitation	831-454-2160	Yes
18	Soquel Sewage Pump Station	121.57.25	36.58.48	Rachel Lather	SC County Sanitation	831-454-2160	Yes
19	Lawn Way Storm Drain Pump Station	121.57.03	36.58.20	Steve Jesberg	City of Capitola	831-475-7300	No
20	Soquel Creek Water District Treatment Plant, Garnet Street	121.57.26	36.58.19	Ron Duncan	Soquel Creek Water District	831-475-8500	Yes
21	Soquel Creek Water District Seawater Intrusion Prevention Well, Monterey Avenue	121.56.39	36.58.56	Ron Duncan	Soquel Creek Water District	831-475-8500	Yes
22	Soquel Creek Water District MacGregor Booster Pumping Station	121.56.08	36.59.00	Ron Duncan	Soquel Creek Water District	831-475-8500	Yes
23	Capitola Beach Flume	121.57.08	36.58.17	Steve Jesberg	City of Capitola	831-475-7300	No
24	Capitola Beach Jetty	121.56.59	36.58.17	Steve Jesberg	City of Capitola	831-475-7300	No
25	Grand Avenue Cliffs	121.56.50	36.58.23	Steve Jesberg	City of Capitola	831-475-7301	No
	Total						

Appendix C – **City of Capitola Coastal Climate Change Vulnerability Report (June 2017)**

City of Capitola

Coastal Climate Change Vulnerability Report


Image: L. Engelking

JUNE 2017

CENTRAL COAST WETLANDS GROUP

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ESA

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The Nature Conservancy

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City of Capitola

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Summary of Findings

This hazard evaluation is intended to provide a predictive chronology of future risks to benefit local coastal planning and foster discussions with state regulatory and funding agencies. Estimates of the extent of assets at risk of various climate hazards were made using best available regional data. This approach allows planners to understand the full range of possible impacts that can be reasonably expected based on the best available science, and build an understanding of the overall risk posed by potential future sea level rise. The hazard maps provide projected hazard zones for each climate scenario for each of the three planning horizons. For clarity, this report focuses the hazard analysis on a subset of those scenarios, recommended by local and state experts.

Key findings for the City of Capitola include:

- Infrastructure closest to the beach will continue to be impacted by the force of waves, the deposition of sand, kelp and other flotsam, and by floodwaters that do not drain between waves.
- Infrastructure further inland is most vulnerable to flooding by a combination of ocean and riverine sources.
- Infrastructure identified as vulnerable to coastal flooding by 2030 is similar to that which is currently vulnerable.
- Total property values at risk from the combined hazards of coastal climate change for 2030 were estimated at $200 million.
- Property value at risk may increase to $275 million dollars by 2060. That value is reduced by approximately $50 million dollars if current coastal armoring is replaced or upgraded.
- By 2060 use of all 12 public access ways may be restricted due to various coastal climate vulnerabilities.
- Projected flood water depths along the river walkway are estimated to be as much as 8 feet by 2060.
- Cliff Drive remains a key western access road into the downtown area and is vulnerable to cliff erosion by 2060 if coastal armoring is not replaced.
- By 2100 most of the beach may be lost due to higher sea levels and beach erosion if back beach structures are rebuilt in their current locations.

- As many as 221 properties are within the 2100 bluff erosion zone if protective structures are not maintained or replaced.
- By 2100 SLR and Fluvial models used in this analysis project that much of the downtown area may be periodically flooded during winter storms and high river discharges.
- By 2100 tidal inundation within portions of the downtown area may become a serious challenge, risking 23 residential and 23 commercial buildings to monthly flooding.
- By 2100, portions of Capitola may be too difficult and costly to protect from the combined hazards of Coastal Climate Change.

This study confirms that coastal flooding will remain a primary risk to low-lying areas of Capitola Village. This study also suggests that river flooding may be of greater risk to the community than previously realized and significant investments will be required to protect all public and private infrastructure from future erosion risks. Establishing strategic managed retreat policies early will likely best enable the long-term implementation of these policies and ensure long term sustainability for the community.

1. Introduction

1.1 Project Goals

This report was funded by The Ocean Protection Council through the Local Coastal Program Sea Level Rise Adaptation Grant Program. This grant program is focused on updating Local Coastal Programs (LCPs), and other plans authorized under the Coastal Act[1] such as Port Master Plans, Long Range Development Plans and Public Works Plans (other Coastal Act authorized plans) to address sea-level rise and climate change impacts, recognizing them as fundamental planning documents for the California coast.

This project will achieve three key objectives to further regional planning for the inevitable impacts associated with sea-level rise (SLR) and the confounding effects of SLR on fluvial processes within the City of Capitola. This project will:

1. Identify what critical coastal infrastructure may be compromised due to SLR and estimate when those risks may occur;
2. Identify how fluvial processes may increase flooding risk to coastal communities in the face of rising seas; and
3. Define appropriate response strategies for these risks and discuss with regional partners the programmatic and policy options that can be adopted within Local Hazard Mitigation Plan and LCP updates.

This report is intended to provide greater detail on the risks to the city from coastal climate change during three future time horizons (2030, 2060 and 2100). Risks to properties were identified using the ESA PWA Monterey Bay Sea Level Rise Vulnerability Study[2] layers developed in 2014 using funding from the California Coastal Conservancy.

The City of Capitola adopted a Hazard Mitigation Plan in May 2013.[3] This plan "identifies critical facilities that are vital to the city's and other local agencies' response during a natural disaster, particularly those that are currently vulnerable or at risk, assesses vulnerability to a variety of natural disasters

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[1] State of California. California Coastal Act of 1976. http://www.coastal.ca.gov/coastact.pdf

[2] ESA PWA. 2014. Monterey Bay Sea Level Rise Vulnerability Study: Technical Methods Report Monterey Bay Sea Level Rise Vulnerability Study. Prepared for The Monterey Bay Sanctuary Foundation, ESA PWA project number D211906.00, June 16, 2014

[3] RBF and Dewberry. 2013. City of Capitola Local Hazard Mitigation Plan. Prepared for the City of Capitola.

(earthquake, flood, coastal erosion, etc.), and identifies needed mitigation actions." Sea level rise is noted as a significant hazard to the city. The plan also sets goals to protect the city from sea level rise. Potential actions listed include integrating the results of this City of Capitola Coastal Hazards Vulnerability Report into the Local Hazard Mitigation Plan risk assessment and incorporating climate change risks and climate adaptation options into the general plan.

1.2 Study Area

The planning area for Capitola's Local Coastal Program encompasses the Coastal Zone within the City of Capitola. However, because the vulnerability study includes a fluvial analysis for Soquel Creek, the study area for the purpose of this report extends outside of the Coastal Zone along Soquel Creek (Figure 1).

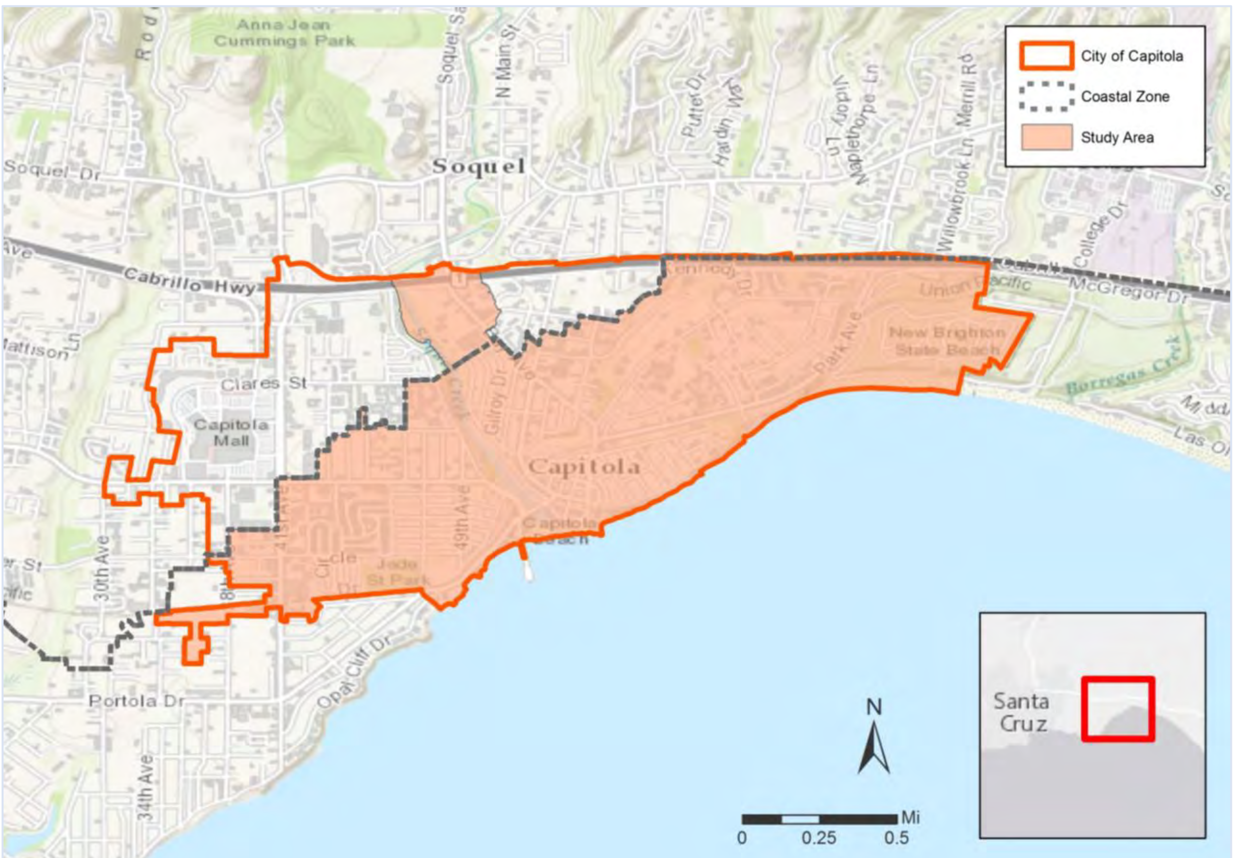

Figure 1. City of Capitola Vulnerability Assessment Study Area with Soquel Creek floodplain

2. Community Profile

2.1 Setting and Climate

Capitola is a small coastal city located in Santa Cruz County in California's Monterey Bay Area (figure 1.). The town was founded in the late 1800's first as a vacation resort. Capitola's main beach is located at the mouth of the Soquel Creek, buffered by coastal cliffs and pocket beaches to the East and West. The Capitola Esplanade provides a pleasant stroll along a row of restaurants, historic homes and small shops and unique vistas of Monterey Bay. In September, Capitola hosts a number of beach front events (Begonia Festival and the Capitola Art & Wine Festival) along the Esplanade.

According to the United States Census Bureau[5], the city has a total area of 1.7 square miles, of which 1.6 square miles is land and 0.1 square miles (5%) is water of Soquel Creek. Capitola's climate is mild with summer temperatures in the mid-70s and winter temperatures in the mid-50s. Capitola has an average of 300 sunny days a year with low humidity for a coastal city. Average rainfall is 31 inches per year, with most of the rainfall occurring between November and April.[4]

2.2 Demographics

The community has a population of 10,189 residents, 52.4% female and 47.6% male. 80.3% identify as white, 1.2% identify as black, 4.3% identify as Asian, and 19.7% identify as Hispanic or Latino (of any race). The median household income is $56,458, and 7.1% of the civilian workforce is unemployed, with 7.4% of people under the poverty line. 92.7% of people have a high school diploma, and 38.3% have a bachelor's degree or higher.[5]

2.3 Community Resources and Assets

Land Use

Critical Facilities*:* Capitola's Police and Fire Stations, as well as City Hall, are located downtown, in close proximity to the beach and the Village. Emergency shelters are located at Jade Street Community Center and New Brighton School, and the Public Library is used as a backup emergency response center. There are several storm and wastewater pump stations, one of which is located in Esplanade Park.

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[4] National Oceanic and Atmospheric Administration. NowData – NOAA Online Weather Data. Retrieved from http://w2.weather.gov/climate/xmacis.php?wfo=ilx (Aug 6, 2016)

[5] United States Census Bureau. 2015. American Community Survey 5-Year Estimates. Retrieved from https://factfinder.census.gov/faces/nav/jsf/pages/community_facts.xhtml (April 2, 2016)

Capitola Village: The downtown commercial and visitor serving district of Capitola supports about 45 tourist shops and 27 other businesses, 20 restaurants and 10 cafes, 4 hotels, and 30 vacation rentals (28 listed).[6] The Village is a true mixed-use district with a diversity of visitor-serving commercial establishments, public amenities, and residential uses.[7,8] Capitola has a popular beach and waterfront area, with the beach area used for tourism, junior lifeguarding, surfing, and more.

Capitola Wharf: The Wharf is a popular destination for fishermen. With its restaurant and great views of Capitola and the ocean, the wharf is popular with tourists and provides access to boat rentals and boat moorings offshore.

Historical Buildings and Districts*:* Based on a 1986 architectural survey of structures prior to 1936, that had retained architectural integrity, Capitola has approximately 240 buildings that "best represented traditional architectural styles locally or the community's vernacular architecture." As a result of the survey, three National Register Historic Districts were established in Capitola in 1987: Venetian Court District, Six Sisters/Lawn Way District, and Old Riverview Historic District.[9]

Recreation and Public Access

Beaches and Parks*:* Capitola Beach is a popular tourist destination and is in close proximity to Capitola Village's shops and restaurants, and the Capitola Wharf. The beach (averaging 5.8 acres of summer sand) supports numerous sports and community events including junior lifeguards program, surfing lessons, sand castle contests, volleyball and other beach activities. There are eight City parks in Capitola, totaling 18 acres, including Monterey Avenue Park, Noble Gulch Park, Peery Park, Soquel Creek Park, Jade Street Park and Esplanade Park. New Brighton State Beach is also located within Capitola.

Coastal Access: Defined coastal access points (with specific access ways to coastal resources) were mapped specifically for this project (Figure 2). There are two stairway coastal access ways and one partially paved ramp near the wharf that are used extensively by the public to reach Capitola beach. The low wall along the Venetian Court allows easy access to

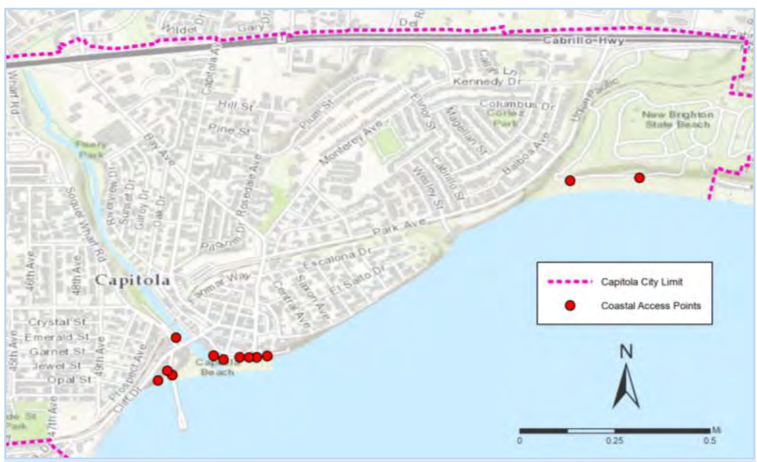

Figure 2. Coastal access points within the City of Capitola

[6] Capitola Village Business Industry Association. Capitola Village. Retrieved from www.capitola village.com (March 2, 2016)

[7] City of Capitola. 2014. Capitola General Plan.

[8] For the purpose of this analysis Capitola building land use was cross-walked with Santa Cruz County and Monterey County land uses so that the analysis could be consistent between jurisdiction, however many of the buildings in the village are actually designated as mixed-use by the City of Capitola.

[9] Swift, C. 2004. Historical Context Statement for the City of Capitola. Prepared for City of Capitola Community Development Department.

the beach along its entire stretch. There are numerous access ways along the Esplanade, all of which can be blocked during winter storms to restrict incoming waves.

Public Visitor Parking: Public parking is distributed throughout the community and includes metered parking along the Esplanade and other downtown streets, several parking lots within the downtown area, and parking lots located within Noble Gulch and above City Hall.

Coastal Trail: The Coastal Trail in Capitola runs along the railroad track and the coastline.

Transportation

Roads*:* Some of the main roads in Capitola Village include Monterey Ave, Cliff Drive, Wharf Road, Stockton Avenue, and the Esplanade. The Stockton Bridge crosses Soquel Creek and connects the cliffs to the Village.

Summer Shuttle*:* There is a free weekend summer shuttle that transports people from parking lots to the beach.

Railroad*:* The railroad through Capitola has been closed to passengers since the 1950s but was recently purchased by the county to provide pedestrian, bike and rail opportunities in the future.[10] The railroad trestle bridge crosses Soquel Creek north of Stockton Bridge.

Natural Resources

Wetland: Soquel Creek and Noble Creek are mapped as Riverine systems by the National Wetland Inventory. The mouth of the creek is mapped as an Estuarine and Marine Wetland.[11]

Kelp Forest: Kelp forests persist offshore of Capitola and provide valuable habitat and fishing opportunities within a short boat ride of the wharf.

Critical Habitat*:* The Soquel Creek is home to several endangered species such as Steelhead Trout and Coho Salmon.[12] Restoration efforts are underway to help these populations recover.

Utilities

Water Infrastructure: The City of Capitola has extensive below ground drinking water, storm drain and wastewater infrastructure within the areas identified as vulnerable. There is a wastewater pump station located next to the Esplanade Park restroom. Storm drain structures discharge to the river and beach.

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[10] Whaley, D., Santa Cruz Trains, Capitola. retrieved from: http://www.santacruztrains.com/2014/11/capitola.html (July 8, 2016)

[11] US Fish and Wildlife Service. National Wetland Inventory. Retrieved from https://www.fws.gov/wetlands/Data/Mapper.html (July, 8, 2016)

[12] California Natural Diversity Database (CNDDB). 2015. Records of Occurrence for Capitola USGS quadrangle. Sacramento, California. 2014. Retrieved from http://www.dfg.ca.gov/biogeodata/cnddb/mapsanddata.asp (October 2015)

Utility Infrastructure*:* PG&E electric and natural gas infrastructure data were not available for this study.

2.4 Historic Events

Capitola has experienced many coastal flooding events caused by high wave action during winter high tides. Table 1 provides a list of these storms. The 1982-1983 El Niño was an extreme example of the periodic impacts this coastal community faces from severe winter storms (Figure 3).

Historical flooding from the river is well documented, including the December 1931 flood, which is depicted as:

> *"Soquel "River" widens to sixty feet, the highest since 1890, damaging property in Soquel and all the way to the mouth at Capitola. Orchards are lost with the rapid rise of water. Hundreds gather to watch the tides batter the concessions at the beach. There is a "vortex of water where the river and sea meet." The waterfront is piled high with flood debris thrown back up the beach."*[13]

On March 26, 2011, a large flood event occurred on the Noble Creek causing a subsurface storm drain pipe to fail during a large winter storm, causing creek waters to flow down Noble Gulch, flooding the downtown commercial district. Commercial and residential properties, including the fire and police stations, were flooded, leading to significant costs for repair.

Figure 3. January 23rd, 1983: high tide, high river flow event in Capitola. (Photo: Minna Hertel)

[13] City of Capitola Historical Museum. 2013. Capitola Local Hazard Mitigation Plan, Appendix A: Timeline of Natural Hazard events impacting the City of Capitola

Table 1. Major Floods in Soquel and Capitola Villages 1890 to Present
(adapted from Appendix A of the Capitola Hazard Mitigation Plan)

NEWSPAPER DATE	HAZARD	DESCRIPTION OF DAMAGE
1862	Flood	Major event—Soquel village inundated; mills, flumes, school, town hall, houses and barns were destroyed. Massive pile of debris went out to sea and then washed ashore at Soquel Landing
1890	Flood	Capitola floods, footbridge and span of wagon bridge destroyed. Esplanade flooded
1906	Flood	Buildings from Loma Prieta Lumber Company camp above Soquel are destroyed. Debris at Capitola.
1913	Storms and Tide	Waves ran across the beach to the Esplanade and water spread “clear to the railroad tracks.” Union Traction Company racks covered with sand. Water reached the Hihn Superintendent’s Building (Capitola and Monterey Avenues), and waves were described as “monster.” About 200 feet of wharf washed away.
1914	Flood	Flood along Soquel Creek
1926	High Tide	High Tide: Waves to 20 feet. Wharf damaged. Sea wall promenade broken at Venetian Courts. Apartments flooded. Breakers slammed into Esplanade, destroying boathouse/bathhouse, beach concessions. Tide hits the second floor of Hotel Capitola. Water runs a foot deep through village
1931	Storm and High Tide	Soquel “River” widens to sixty feet, the highest since 1890, damaging property in Soquel and all the way to the mouth at Capitola. The creek cuts across the beach and moves sand below the new outlet.
1935	Flood	Capitola Village floods; thirty feet of the sea wall is taken out. Beach playground disappears. Venetian Courts hit hard but damage minimal.
1940	Flood	Logs pile against bridge in downtown Soquel and village floods. Landslides in watershed.
1955	Flood	Capitola exceeded $1 million damage including the Venetian Courts. Noble Creek and Tannery Creek also flooded.
1982-1983	El Nino Storm and High Tide	Early winter storms initiated erosion and left the beaches eroded and vulnerable to subsequent storms in January-February 1983.
1995	Flood	The creek rose near the village.
1997-1998	Flood	Yards and basements of homes along both sides of Soquel Creek near the village were flooded.
2011	Flood	Noble Creek floods village; Tannery Creek rushes through New Brighton State Park parking lot and undermines the cliff roadway within the State Park

2.5 Coastal Protection Infrastructure and Management

There are 1.2 miles of sea walls and rip-rap that protect coastal structures from winter storms and wave impacts. Capitola's downtown commercial district is currently protected from winter storms by low hip-walls along the Esplanade and Venetian Court and a large concrete wall that protects portions of the eastern cliff from erosion. Two rip-rap groins on the east end of the beach lay perpendicular to the Esplanade and help accumulate sand and increase the width of the beach. Rip-rap protects the cliffs west of the wharf and concrete walls maintain the edge of the creek under restaurants along the Esplanade (Figure 4). Table 2 outlines the existing coastal armoring that helps protect Capitola from coastal hazards.

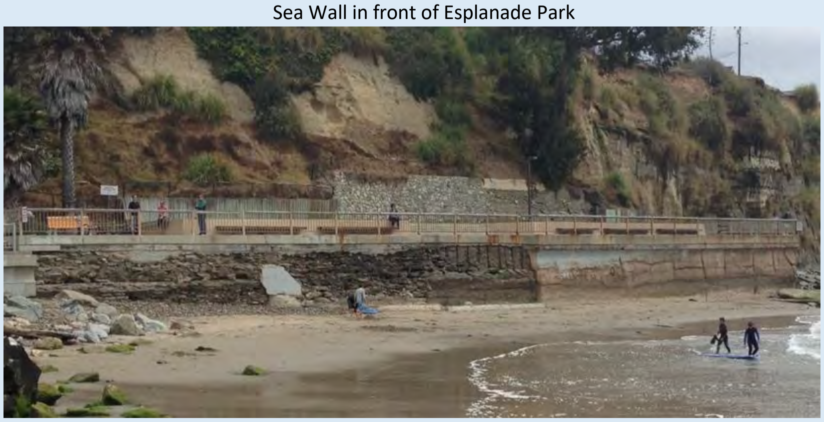
The Soquel River mouth lagoon is actively managed to minimize flooding during the winter and maximize recreational opportunities during the summer. The river mouth is closed before Memorial Day and remains closed (draining excess flow through the concrete spillway) until after Labor Day. The river is mechanically breached in the fall to reconnect the lagoon with the ocean and prepare for increased flows during winter storms. The lower 2000 feet of the river are channelized and restricted by a combination of wood and concrete channel walls. Private yards and a public access trail parallel the channel from the Stockton Ave Bridge inland 800 feet to the Noble creek culvert and Blue Gum Ave.

Table 2. Inventory of Existing Coastal Protection Structures in Capitola

STRUCTURE LOCATION	TYPE OF STRUCTURE	PUBLIC OR PRIVATELY OWNED
Grand Ave, eastern end of promenade, below Crest apartment	Retaining wall	Public
Grand Ave, eastern end of promenade, below Crest apartment	Concrete wall	Private
Esplanade, seaward of road and parking lot	Concrete wall	Public
Esplanade, in front of restaurant	Revetment	Public
Esplanade, in front of Zeldas at inlet of river	Revetment	Public
Seaward of Venetian Court adjacent to Capitola Beach	Wall	Private
Cliff Drive, seaward of residences at beach	Revetment	Private
Cliff Drive, at the top of coastal bluff underneath recreation path	Retaining wall	Public
Cliff Drive, seaward of road at base of bluff	Revetment	Public
Opal Cliff Drive, seaward of residence on the upper portion of bluff	Surface armor	Private
Grove Lane, base of cliff	Revetment	Private

COASTAL PROTECTIONS

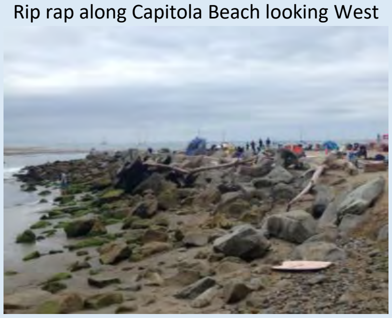
Sea Wall in front of Esplanade Park



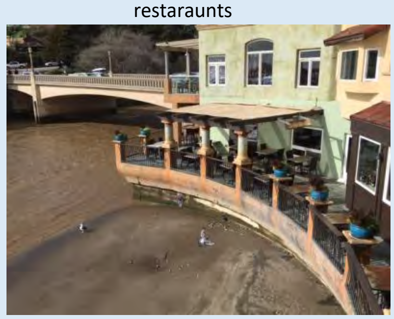
Hip wall in front of the Venetian

Rip rap against cliff below Cliff Drive

Rip rap along Capitola Beach looking West



Hip wall in front of Village Center restaraunts



Jetty off Capitola Beach looking East

Hip wall in front of the Esplanade

Figure 4. Coastal Protection Structures around the City of Capitola
(Photos: Ross Clark and Sarah Stoner-Duncan)

The coastal protection structures within Capitola are of various ages, conditions and levels of service. The current condition of these structures (sea walls, rip-rap and groins) was evaluated with the intent of estimating the expected future lifespan of these structures. Observational data were collected for the dominant structures along the city coastline. The technical team determined that these field observations can be used to provide some estimate of future life expectancy, but not at a level of certainty any more precise than assuming that all current coastal protection infrastructure will need to be replaced or significantly improved at some point between 2030 and 2060.

3. Projecting Impacts

3.1. Disclaimer: Hazard Mapping and Vulnerability Assessment

Funding Agencies

The hazard GIS layers were created with funding from The Coastal Conservancy and this Vulnerability Analysis was prepared with funding from the Ocean Protection Council. The results and recommendations within these planning documents do not necessarily represent the views of the funding agencies, its respective officers, agents and employees, subcontractors, or the State of California. The funding agencies, the State of California, and their respective officers, employees, agents, contractors, and subcontractors make no warranty, express or implied, and assume no responsibility or liability, for the results of any actions taken or other information developed based on this report; nor does any party represent that the uses of this information will not infringe upon privately owned rights. These study results are being made available for informational purposes only and have not been approved or disapproved by the funding agencies, nor has the funding agencies passed upon the accuracy, currency, completeness, or adequacy of the information in this report. Users of this information agree by their use to hold blameless each of the funding agencies, study participants and authors for any liability associated with its use in any form.

ESA PWA Hazard Layers

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CCWG Vulnerability Assessment

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3.2. Coastal Hazard Processes

The ESA coastal hazard modeling and mapping effort[14] led to a set of common maps that integrate the multiple coastal hazards projected for each community (i.e. hazards of coastal climate change). There is however a benefit to evaluating each hazard (or coastal process) separately. Two important limitations of the original hazard maps were addressed within this focus effort for Capitola. ESA was contracted for this project to model the combined effects of rising seas and increased winter stream flows due to future changes in rainfall. CCWG staff further accounted for reductions in potential hazards provided by current coastal protection infrastructure (see section 3.4). This refinement of coastal hazard mapping helped to better understand the future risks Capitola may face from each coastal hazard process.

Each modeled coastal process will impact various coastal resources and structures differently. This report evaluates the risks to infrastructure from each coastal hazard process for each time horizon. The following is a description of the hazard zone maps that were used for this analysis. For more information on the coastal processes and the methodology used to create the hazard zones please see the Monterey Bay SLR Vulnerability Assessment Technical Methods Report.[15]

FEMA

FEMA flood hazard maps are used for the National Flood Insurance Program and present coastal and fluvial flood hazards. These flood maps were used to identify current hazards as defined by FEMA. These maps, however, are believed to underestimate coastal flood hazards for future time horizons.

Combined Hazards

CCWG merged the coastal hazard layers provided by ESA to create a new combined hazard layer for each planning horizon (2030, 2060 and 2100). These merged layers represent the combined vulnerability zone for "Coastal Climate Change" for each time horizon. Projections of the combined hazards of Coastal

[14] ESA PWA. 2014. Monterey Bay Sea Level Rise Vulnerability Assessment Technical Methods Report

[15] Ibid.

Climate Change are intended to help estimate the cumulative effects on the community and help identify areas where revised building guidelines or other adaptation strategies may be appropriate. Combined hazards however, do not provide municipal staff with the necessary information to select specific structural adaptation responses. Therefore, this study also evaluates the risks associated with each individual coastal hazard.

Rising Tides

These hazard zones show the area and depth of inundation caused simply by rising tide and ground water levels (not considering storms, erosion, or river discharge). The water level mapped in these inundation areas is the Extreme Monthly High Water (EMHW) level, which is the high water level reached approximately once a month. There are two types of inundation areas: (1) areas that are clearly connected over the existing digital elevation through low topography, (2) and other low-lying areas that don't have an apparent connection, as indicated by the digital elevation model, but are low-lying and flood prone from groundwater levels and any connections (culverts, storm drains and underpasses) that are not captured by the digital elevation model. This difference is captured in the "Connection" attribute (either "connected to ocean over topography" or "connectivity uncertain") in each Rising Tides dataset. These zones do not, however, consider coastal erosion or wave overtopping, which may change the extent and depth of regular tidal flooding in the future. Projected risks from rising tides lead to reoccurring flooding hazards during monthly high tide events.

Coastal Storm Flooding

These hazard zones depict the predicted flooding caused by future coastal storms. The processes that drive these hazards include (1) storm surge (a rise in the ocean water level caused by waves and pressure changes during a storm), (2) wave overtopping (waves running up over the beach and flowing into low-lying areas, calculated using the maximum historical wave conditions), and (3) additional flooding caused when rising sea level exacerbate storm surge and wave overtopping. These hazard zones also take into account areas that are projected to erode, sometimes leading to additional flooding through new hydraulic connections between the ocean and low-lying areas. These hazard zones do NOT consider upland fluvial (river) flooding and local rain/run-off drainage, which likely play a large part in coastal flooding, especially around coastal confluences where creeks meet the ocean. Storm flood risks represent periodic wave impact and flooding.

Cliff and Dune Erosion

These layers represent future cliff and dune (sandy beach) erosion hazard zones, incorporating site-specific historic trends in erosion, additional erosion caused by accelerating sea level rise and (in the case of the storm erosion hazard zones) the potential erosion impact of a large storm wave event. The inland extent of the hazard zones represents projections of the future crest of the dunes, or future potential cliff edge, for a given sea level rise scenario and planning horizon. Erosion can lead to a complete loss of habitat, infrastructure and/or use of properties.

Fluvial Flooding

An additional river flooding vulnerability analysis was done as part of this study to evaluate the cumulative impacts of rising seas and future changes in fluvial discharge due to changes in rainfall within the Soquel watershed. The ESA modeling team expanded hydrologic models of the Soquel watershed provided by the County to estimate discharge rates under future climate scenarios. The fluvial model estimates localized flooding along the Soquel Creek when discharge is restricted by future high tides. The model results are presented here and reviewed within the separate Fluvial Report by ESA.[16]

3.3. Scenario Selection and Hazards

The California Coastal Commission guidance document[17] recommends all communities evaluate the impacts from sea level rise on various land uses. The guidance recommends using a method called "scenario-based analysis" (described in Chapter 3 of this Guidance). Since sea level rise projections are not exact, but rather presented in ranges, scenario-based planning includes examining the consequences of multiple rates of sea level rise, plus extreme water levels from storms and El Niño events. As recommended in the Coastal Commission guidance, this report uses sea level rise projections outlined in the 2012 NRC Report, *Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future*[18] (Figure 5). The goal of scenario-based analysis for sea level rise is to understand where and at what point sea level rise and the combination of sea level rise and storms, pose risks to coastal resources or threaten the health and safety of a developed area. This approach allows planners to understand the full range of possible impacts that can be reasonably expected based on the best available science, and build an understanding of the overall risk posed by potential future sea level rise. The coastal climate change vulnerability maps used for this study identify hazard zones for each climate scenario for each of the three planning horizons. For clarity, this report focuses the hazard analysis on a subset of those scenarios,

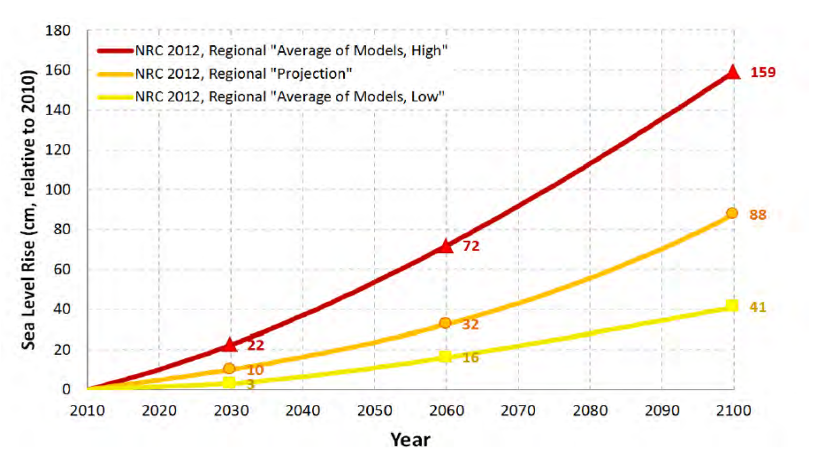


Figure 5. Sea Level Rise scenarios for each time horizon
(Figure source: ESA PWA 2014)

[16] ESA. 2016. Climate Change Impacts to Combined Fluvial and Coastal Hazards. May 13, 2016.

[17] California Coastal Commission. 2015. California Coastal Commission Sea Level Rise Policy Guidance: Interpretative Guidelines for Addressing Sea Level Rise in Local Coastal Programs and Coastal Development Permits. Adopted August 12, 2015.

[18] National Research Council (NRC). 2012. Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future. Report by the Committee on Sea Level Rise in California, Oregon, and Washington. National Academies Press, Washington, DC. 250 pp.

recommended by local and state experts (Table 3).

The Coastal Commission recommends all communities evaluate the impacts of the highest water level conditions that are projected to occur in the planning area. Local governments may also consider including higher scenarios (such as a 6.6 ft (2m) Scenario) where severe impacts to Coastal Act resources and development could occur from sea level rise. We use a similarly high scenario of 1.59m with an increase in projected storm intensity for this analysis (Table 3). In addition to evaluating the worst-case scenario, planners need to understand the minimum amount of sea level rise that may cause impacts for their community, and how these impacts may change over time.

Table 3. Sea level rise scenarios selected for analysis

TIME HORIZON	EMISSIONS SCENARIO	SLR	NOTES
2030	med	0.3 ft (10 cm)	Erosion projection: Includes long-term erosion and the potential erosion of a large storm event (e.g. 100-year storm)
2060	high	2.4 ft (72 cm)	Erosion projection: Includes long-term erosion and the potential erosion of a large storm event (e.g. 100-year storm) Future erosion scenario: Increased storminess (doubling of El Niño storm impacts in a decade)
2100	high	5.2 ft (159 cm)	Erosion projection: Includes long-term erosion and the potential erosion of a large storm event (e.g. 100-year storm) Future erosion scenario: Increased storminess (doubling of El Niño storm impacts in a decade)

3.4. Assumptions and Modifications to ESA Hazard Zones

Coastal Armoring

The ESA coastal hazard projections do not account for the protections that existing coastal armoring provide. The areas identified as vulnerable by the original coastal erosion ESA GIS layers overestimate future hazard zones (as recognized within the ESA supporting documentation). A GIS layer of existing coastal armoring was referenced within this analysis to recognize areas where some level of protection currently exists.[19]

To account for the protections provided by coastal armor, properties and structures located behind those structures were in most cases reclassified as protected from erosion for the 2030 erosion vulnerability analysis. Coastal flooding layers, however, did account for the height of coastal structures (hip walls etc.) and estimate wave overtopping and flooding that may occur with those structures in place. Some structures were therefore identified as protected from coastal erosion and vulnerable to coastal flooding.

[19] California Coastal Commission. 2014. GIS layer of existing coastal armor structures in Santa Cruz County.

Because the life span of coastal infrastructure is limited, this vulnerability analysis assumes that all existing coastal protection infrastructure will fail and may need to be removed, replaced or significantly redesigned at some point between 2030 and 2060. If these structures are removed once they fail, erosion will accelerate and quickly meet projected inland migration rates (as documented at Stilwell Hall, Fort Ord) unless protective measures are implemented. Therefore, the vulnerability analysis for the 2060 and 2100 planning horizons assumes that current coastal armoring will no longer function and that the modeled hazard zone layers provided by the ESA technical team fully represent future hazards for these time horizons.

Erosion

Cliff erosion and dune erosion were originally two sets of separate coastal hazard layers provided by ESA-PWA. Cliff erosion was characterized as erosion of mudstone cliff sides generally along the Santa Cruz County coastline. Whereas dune erosion was characterized as erosion of sandy slopes predominantly found along the Monterey Bay coastline. Since these two hazards were functionally different and spatially separate, it was decided to merge them into one set of 'Erosion' coastal hazard process layers using the 'Merge' tool within ArcGIS. Therefore, for each time horizon both cliff erosion and dune erosion impact zones were combined into a single erosion impact zone. The 'erosion' coastal hazard series was used throughout the analysis and included in the tables. Erosion hazard layers were modified as described above to account for the protections provided by existing seawalls through 2030.

Coastal Storm Flooding

The ESA hazard layers included cliff areas predicted to have eroded during previous time horizons as being vulnerable to coastal flooding hazards, because the land elevation within those areas was assumed to have been reduced due to that cliff erosion. For example, sections of cliff in Capitola that are projected to erode by 2060 (after coastal armoring is assumed to no longer function) are also projected to experience coastal flooding and wave over-topping within those newly eroded coastal areas. This is an accurate interpretation of the projected coastal processes but does not reflect the progression of asset losses. For simplicity, Cliff top assets predicted to be vulnerable to coastal flooding for the 2060 and 2100 planning are reported as vulnerable. This is likely inaccurate because those assets would likely no longer be present but lost due to previous impacts from coastal erosion.

To more accurately represent coastal flooding and wave over-topping vulnerabilities of low-lying assets behind coastal armoring for the Existing (2010) and 2030 planning horizons, assets located below the 20- foot topographic contour line along the base of existing cliffs were reported to be vulnerable.

3.5. Assets Used in Analysis

For this study, city infrastructure and assets were categorized as: Land Use and Buildings; Water and Utility Infrastructure; Recreation and Public Access; Transportation; Natural Resources and Other. GIS layers were obtained from data repositories, or created by the Central Coast Wetlands Group. In some cases, assets that were used in the analysis fell outside of the planning area and therefore were not included in this report. Further, several data layers that were intended to be used in this analysis were not available. Table 4 lists the assets used in the analysis.

Table 4. List of Data Layers used for Analysis

ASSET CATEGORY	ASSET	STATUS OF ASSET IN ANALYSIS
Land Use	Building footprints	Analyzed
	Commercial, Residential, Public, Visitor Serving	Analyzed
	Emergency Services: Hospitals, Fire, Police	Analyzed
	Schools, Libraries, Community Centers	Analyzed
	Parcels	Not used in analysis[20]
	Farmland	None in Planning Area
	Military	None in Planning Area
	Historical and Cultural Designated Buildings	Analyzed, but not reported[21]
Water and Utilities	Sewer Structures & Conduits	Analyzed
	Water Main Lines	Analyzed
	Gas	Unable to obtain for analysis
	Storm Drain Structures & Conduits	Analyzed
	Tide gates	None in Planning Area
Recreation and Public Access	Coastal Access Points	Analyzed
	Parks	Analyzed, but not reported[22]
	Beaches	Analyzed
	Coastal Trail	Analyzed
	Coastal Access Parking	Analyzed
Transportation	Roads	Analyzed[23]
	Rail	Analyzed
	Bridges	Analyzed
	Tunnels	None in Planning Area
Natural Resources	Wetlands	Analyzed
	Critical Habitat	Analyzed, but not reported[24]
	Dunes	None in Planning Area
Other	Hazmat cleanup sites, Landfills, etc.	None in Planning Area

[20] Building foot print layers were used instead of parcels maps to better project future structural vulnerabilities.

[21] The data are available but not reported within this document.

[22] The parks layer included acres of State Beaches as well as City Parks and was duplicative with the Beach impact analysis. City parks vulnerable to various hazards are listed within the text but not included in tabular form.

[23] All projected impacts to Hwy 1 were determined to be unreliable in this area due to the height of the roadway.

[24] Critical habitat data layers were not of high enough resolution to provide accurate estimates of impacts.

4. Combined Impacts of Coastal Climate Change

4.1 Background

Predicted storm driven hazards to the Capitola shoreline and low-lying areas was derived by compiling the geographic extend of hazard areas for a combination of different coastal processes. Waves can damage buildings through blunt force impact, often damaging exterior doors and window, railings, stairways and walkways. Waves that overtop beaches and coastal structures lead to flooding of low lying areas. Flooding is often exacerbated by coastal walls and malfunctioning storm drains that impede drainage of those waters back to the ocean. Future risks of flooding and wave damage may be magnified as higher local sea levels and greater wave heights combined with higher river discharges during winter storms. Greater wave impact intensity may cause greater damage to coastal structures and greater wave heights may extend risks of damage further inland as waves overtop coastal structures more intensively and propagate further up the Soquel Creek. These cumulative threats are termed within this document as the risks of "Coastal Climate Change."[25]

4.2 Existing Vulnerability

FEMA

FEMA maps identify a large portion of the Capitola Village as vulnerable to riverine flooding during a 100-year flood event (Figure 6). Similar flooding occurred during the 2011 Noble Gulch event that flooded much of the downtown commercial district. A total of 262 mixed use buildings, more than 6,500 feet of roadway, 6,800 feet of storm drain pipe and 132 storm drain boxes are located within the FEMA hazard map 100-year flood zone (Table 5).

Flooding within the FEMA hazard map areas is expected to become more severe (although not currently recognized by FEMA) due to changing rainfall patterns associated with climate change. Future threats from increased river flows during these less frequent but more intense rain events were investigated within this project and are reported in Section 5.4.

[25] This study did not investigate the risks from increased heat, decreases in water supply or increases in threats from fire that are also predicted for Santa Cruz County due to climate change.

Existing (2010 with Armoring)

The combined risks of Coastal Climate Change from current climatic conditions (2010 model year) were evaluated for Capitola (Figure 6). The ESA coastal hazard modeling results for the 2010 planning year overlay 62 residential and 134 commercial properties, suggesting they are presently vulnerable to the impacts of storm flooding, classified as Coastal Climate Change (Table 5).

To note, FEMA flood maps do not account for projected sea level rise which may lead to greater regularity of flooding than that FEMA 100-year flood zone identifies. Figure 6 compares assets that lie within the FEMA hazard zone and the modified 2010 combined coastal climate change hazard zone. Many of the additional residents that fall within the FEMA hazard zone are located further upstream along the river outside of the zone threatened by storm induced ocean swells. One of the main emergency service facilities (Capitola fire station) is within this flood hazard area, and was impacted during the 2011 flood. The police station falls outside of the ESA modeled existing (2010) hazard zone, but within the FEMA 100-year flood hazard zone. The station was also impacted during the 2011 flood.

Figure 6. Existing (2010) Flood Hazard Zone Compared to FEMA 100-Year Flood zone

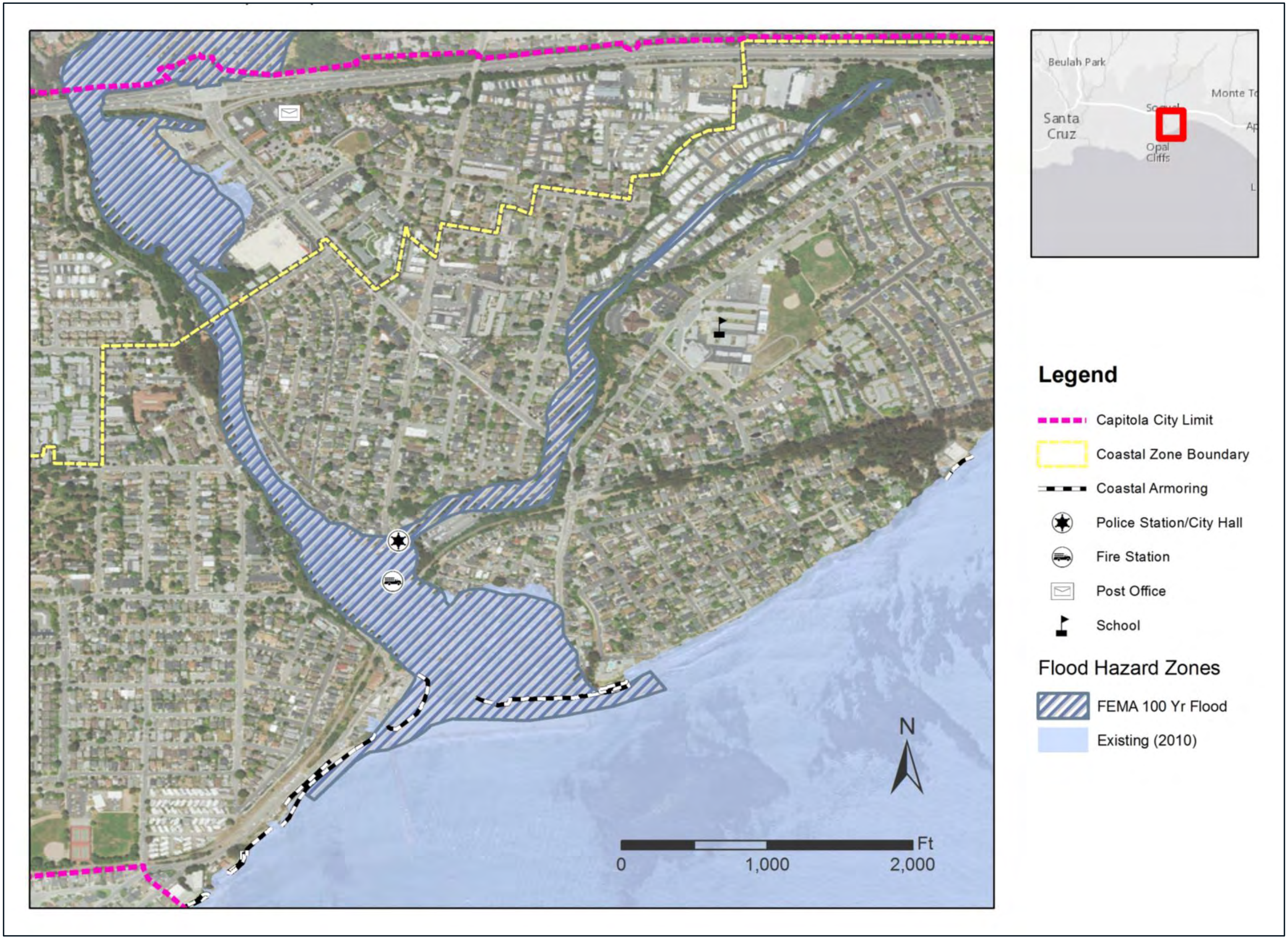


Table 5. Existing Conditions Comparison between FEMA and Existing (2010) hazard layers.

ASSET	UNIT	TOTAL	FEMA	2010 (WITH ARMOR)
Land Use and Buildings				
Total Buildings	Count	3,025	262	206
Residential	Count	2,600	122	62
Commercial	Count	326	132	134
Public	Count	67	6	6
Visitor Serving	Count	15	2	4
Other	Count	17	0	0
Schools	Count	1	0	0
Post Offices	Count	1	0	0
Emergency Services	Count	2	2	0
Transportation				
Roads	Feet	119,994	6,651	6,473
Rail	Feet	8,503	496	422
Bridges	Count	4	3	3
Recreation and Public Access				
Beaches	Acres	5.8	3.9	6
Coastal Access Points	Count	12	9	11
Parking Lots	Acres	4	1	0.7
Coastal Trail	Feet	9,543	0	0
Water and Utility Infrastructure				
Storm Drain Structures	Count	667	132	160
Storm Drain Conduits	Feet	50,173	6,869	8,039
Sewer Structures	Count	472	59	55
Sewer Conduits	Feet	118,365	12,555	12,636
Water Mains	Feet	144,206	11,946	12,857
Natural Resources				
National Wetlands	Acres	16	10	16

4.3 Summary of Future Vulnerabilities by Planning Horizon

Due to climate change, the cumulative number of Capitola properties and infrastructure at risk increases as projected ocean water elevation and storm intensity increase (Table 6). There is a significant increase in the number of properties projected to be at risk of coastal climate change impacts after the 2030 planning horizon. This increase in vulnerability is driven by two assumptions made when interpreting the model outputs. First, by 2060 ocean levels are estimated to rise by 72 cm[26], leading to a greater portion of the downtown area being vulnerable to flooding during winter storms. Flood waters in the downtown area are projected to be higher due to increased wave energy and higher tides pushing more water past current beachfront infrastructure. Some buildings within the downtown area at elevations that do not flood today may be affected by flooding in the future.

Secondly, the technical team determined that it is likely that all coastal protection infrastructure (sea walls, rip-rap, and groins) will need to be replaced or significantly improved at some point before 2060, and therefore the 2060 and 2100 coastal erosion analyses do not account for the protections provided by existing structures. Rather, the analysis accounts for the expected lifespan of coastal structures and assumes that future actions must be taken to replace structures if the community intends to protect structures from these projected hazards. This approach to future hazard analysis recognizes that current coastal armoring may continue to provide protection from wave impacts through 2030 but may fail prior to 2060.

2030

For 2030, the vulnerability analysis was completed assuming that current coastal protective structures would still be present and functioning. A total of 219 buildings are vulnerable to coastal climate impacts by 2030, only 13 more properties than currently at risk (2010 vulnerability assessment). This suggests that current coastal protection infrastructure does not provide full protection from all future hazards.

More than 7,000 linear feet of roadway may be vulnerable to coastal climate change (primarily flooding) by 2030 and approximately 10% of sewer and storm drain infrastructure is within the identified hazard areas. Roads and utilities are not equally vulnerable to different coastal hazards (flooding, erosion etc.) and therefore the analysis of individual coastal hazards (Section 5) may be more useful for response planning.

2060

By 2060, 113 residential buildings and 166 commercial mixed use buildings may become vulnerable to the combined effects of coastal climate change. Only 76 additional buildings are vulnerable to Coastal Climate Change by 2060 than are vulnerable in 2030 even though the 2060 vulnerability model no longer accounts for protections provided by current coastal armoring. Risks to roadways nearly double (in linear feet) by 2060, reflecting the predicted loss of protections provided by coastal armoring for Cliff

[26] National Research Council (NRC). 2012. Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future.

Drive. Upgraded coastal armoring is estimated to cost between $20 and $52 million per mile ($10,000 per linear foot) to construct.[27]

2100

By 2100 the combined models used in this analysis project that much of the downtown area may be flooded during winter storms and high river discharges. Furthermore, most of the dry beach (98%) may be lost due to higher sea levels and beach erosion if back beach structures are rebuilt in their current locations. Further, hundreds of storm drain structures may be compromised and may become conduits for inland flooding if modifications are not made.

By 2100 the impacts experienced periodically during large winter storms may become more frequent and for many coastal properties, may become an annual event. Wave run-up energy may impact structures during most high tides causing flood and wave damage. River flooding is projected to be more frequent and threats of coastal erosion may become more significant as ocean forces migrate inland and impact structures more routinely and forcefully. Maintaining and replacing coastal armoring may become more costly and difficult to engineer. By 2100, portions of Capitola may be too difficult and costly to protect from the combined hazards of Coastal Climate Change.

[27] Evaluation of erosion mitigation alternatives for Southern Monterey Bay, ESA PWA 2012.

Figure 7. Future Combined Coastal Climate Change Hazard Zones (2030, 2060, 2100)

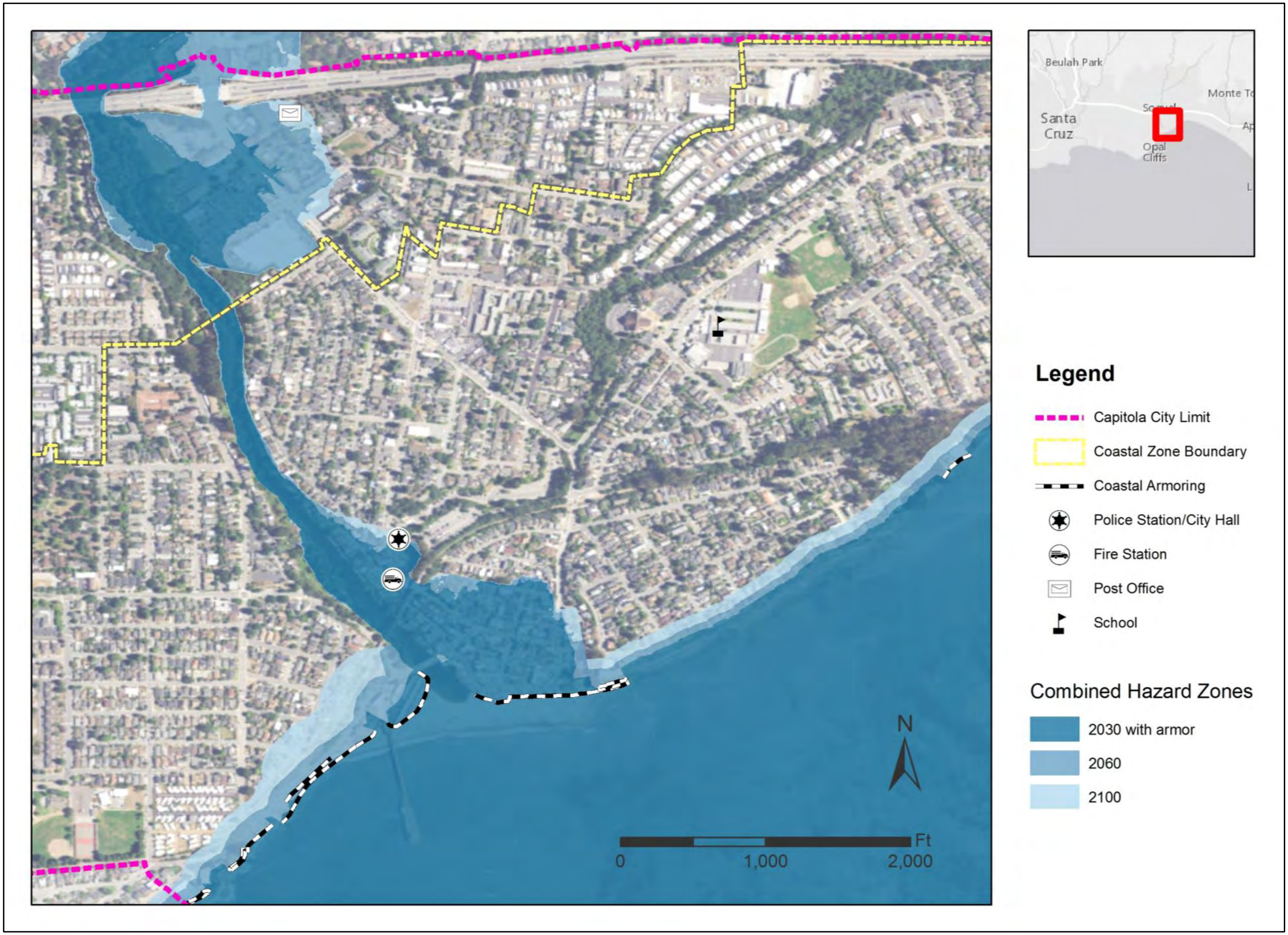
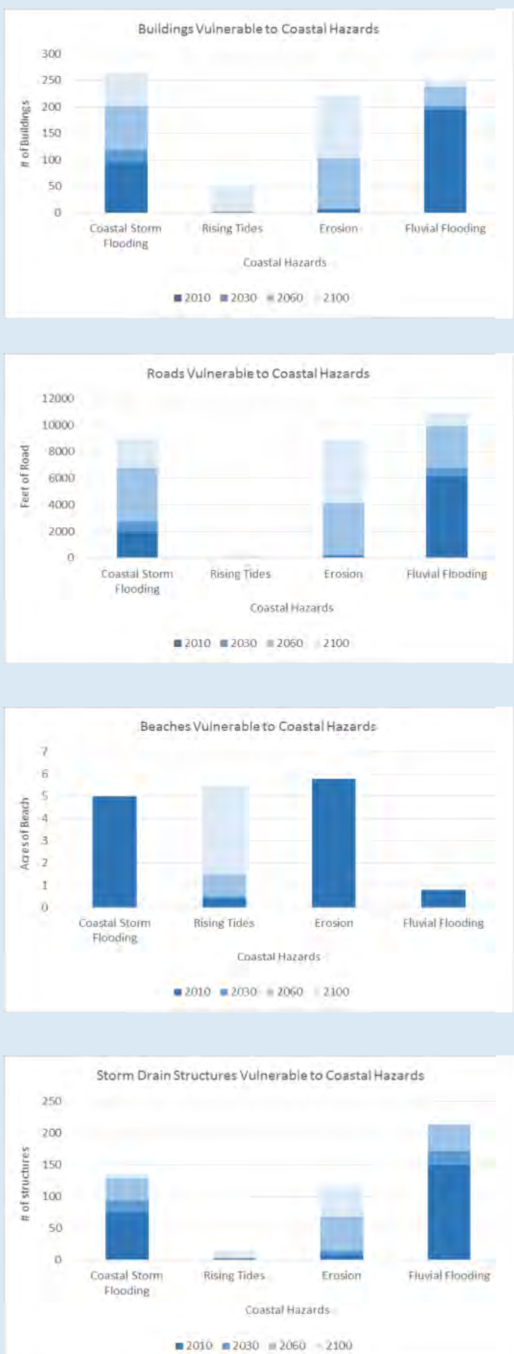


Table 6. Summary of Assets Vulnerable to all Coastal Hazards at 2030, 2060, and 2100

ASSET	UNIT	TOTAL	2030 (WITH ARMOR)	2060 (NO ARMOR)	2100 (NO ARMOR)
Land Use and Buildings					
Total Buildings	Count	3,025	219	295	370
Residential	Count	2,600	68	113	176
Commercial	Count	326	138	166	172
Public	Count	67	7	9	13
Visitor Serving	Count	15	6	7	9
Other	Count	17	0	0	0
Public Facilities	Count	16	0	0	0
Schools	Count	1	0	0	0
Post Offices	Count	1	0	0	1
Emergency Services	Count	2	1	2	2
Transportation					
Roads	Feet	119,994	7,012	13,316	17,138
Rail	Feet	8,503	422	2,076	3,261
Bridges	Count	4	3	3	4
Recreation and Public Access					
Beaches	Acres	5.8	5.8	5.8	5.8
Coastal Access Points	Count	12	11	12	12
Parking Lots	Acres	4	0.7	1.4	1.9
Coastal Trail	Feet	9,543	0	1,705	3,020
Water and Utility Infrastructure					
Storm Drain Structures	Count	667	185	239	244
Storm Drain Conduits	Feet	50,173	8,686	11,864	11,992
Sewer Structures	Count	472	56	83	102
Sewer Conduits	Feet	118,365	13,452	19,819	23,901
Water Mains	Feet	144,206	13,744	19,360	23,339
Natural Resources					
National Wetlands	Acres	16	16	16	16

5. Vulnerability by Individual Coastal Hazard



Estimating the risks from the combined hazards of Coastal Climate Change can help establish areas for modified building guidelines and estimate the cumulative effects on sectors of the social and economic community. Combined hazards, however, do not provide city staff with the necessary information to select appropriate adaptation responses. Therefore, to better link vulnerabilities with adaptation alternatives (Section 7), this project has evaluated the temporal risks of infrastructure for each time horizon and for each coastal hazard process separately.

The risks associated with each of the modeled coastal processes (wave run-up and overtopping, coastal erosion, rising tides and fluvial flooding) threaten various types of coastal infrastructure differently. Wave and fluvial flooding can damage buildings, temporarily restrict use of public amenities, make storm drains and tide gates ineffective and limit the use of roads and walkways. Many of these impacts are temporary and repairs can be made. Cliff erosion and monthly high tide flooding, however, are permanent impacts and may require extensive rebuilding, a change in property use or the abandonment of the property. In Section 7 of this report we investigate possible adaptation strategies for properties at risk from these various hazards.

Figure 8. Assets vulnerable to coastal climate change hazards at each time horizon

5.1 Vulnerability to Hazards by Time Horizon

Different hazards threaten different assets more significantly at different times (Figure 8). River and coastal storm flooding hazards threaten the greatest number of buildings up through 2030. Coastal erosion begins to threaten similar numbers of buildings between 2060 and 2100. Storm drains and roads are vulnerable to river flooding as well and erosion threatens more infrastructure by 2060. By 2100, Capitola beach is potentially lost due to frequent tidal flooding.

5.2 Vulnerability to Rising Tides

Flooding from the predicted increases in monthly high tides (due to local sea level rise) poses minimal threat to Capitola until 2100. Table 7 outlines the projected impacts to assets within Capitola from rising tides. Tidal inundation poses unique threats to low lying areas that may be difficult for many types of development to adapt. Specifically, monthly tidal flooding may lead to salt water damage and a reduction in reliability and availability of some properties and infrastructure. Monthly tidal flooding poses long term maintenance issues and the loss of public service reliability.

Land Use and Buildings

Projected inundation from 2060 high tides is limited. By 2100 high tides may become a more serious risk and may impact 23 residential and 23 commercial properties along Soquel Creek. The areas projected to be vulnerable to tidal flooding by 2100 (mainly properties along the creek) may need to be elevated by approximately 20-40cm to be above projected tidal range.

Transportation

Few roads are projected to be at risk from rising tides till 2100. By 2100, one street (Riverview Ave) may be flooded monthly.

Recreation and Public Access

Rising tides may lead to a reduction in beach width and a loss of recreational opportunities. By 2100 the Capitola main beach width is estimated to be reduced by 95% if back shore structures remain in their current location. By 2100 high tides may temporarily impact four of the 12 public access ways.

Water and Utilities

Two storm drains are already under water along the Soquel Creek. The number of storm drains that will be below mean water elevation in the river and ocean may increase to 13 by 2100.

Natural Resources

Higher tides driven by sea level rise may modify hydrology of the Soquel Creek and flood up to 2/3 of existing wetland habitat monthly with salt water by 2100. These wetlands will likely transition towards a brackish water ecosystem.

Figure 9. Buildings Vulnerable to Rising Tides

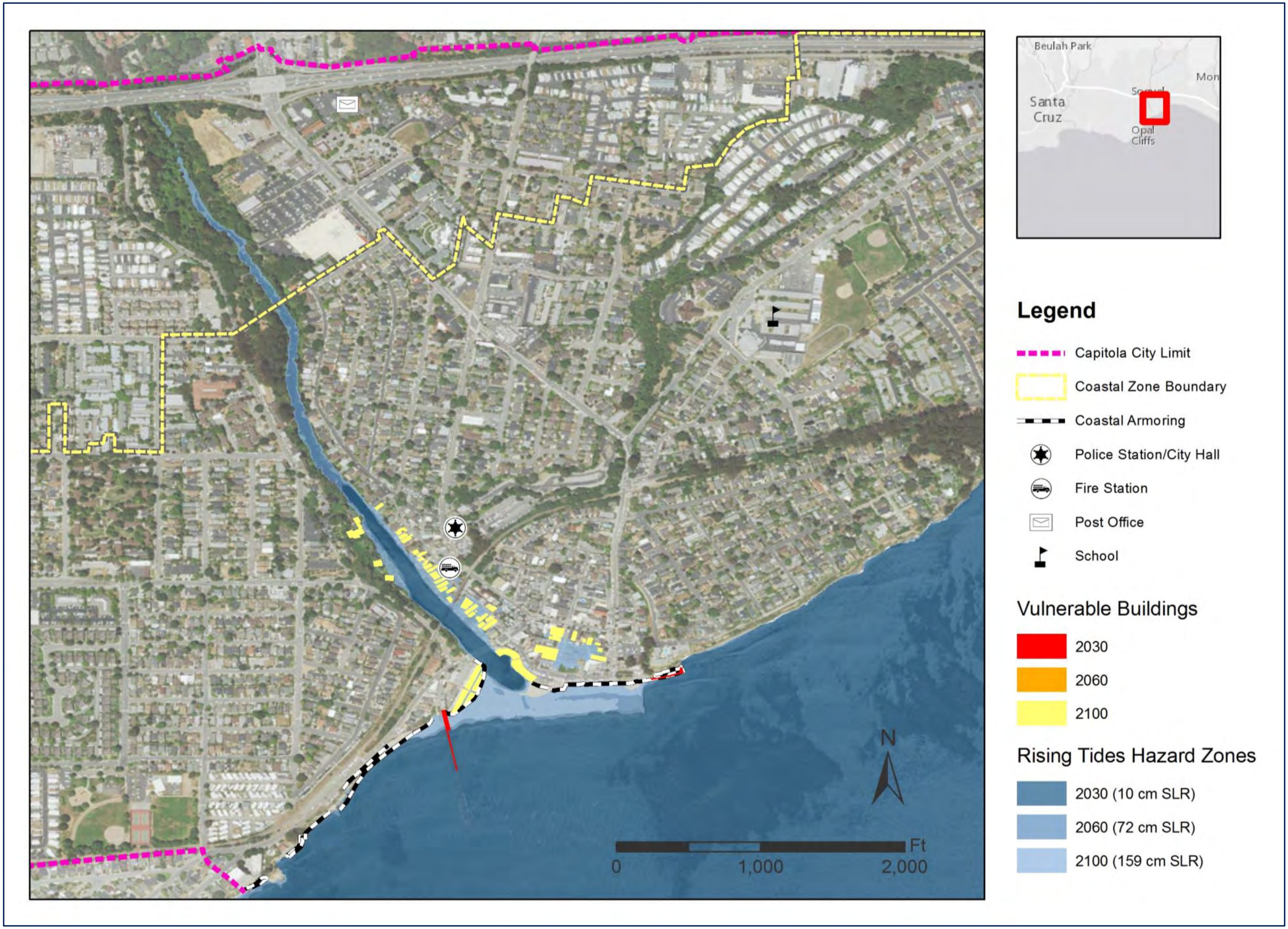


Table 7. Summary of Assets Vulnerable to Impacts by Rising Tides

ASSET	UNIT	TOTAL	2010 (WITH ARMOR)	2030 (WITH ARMOR)	2060 (NO ARMOR)	2100 (NO ARMOR)
Land Use and Buildings						
Total Buildings	Count	3,025	1	1	2	48
Residential	Count	2,600	0	0	1	23
Commercial	Count	326	0	0	0	23
Public	Count	67	1	1	1	1
Visitor Serving	Count	15	0	0	0	1
Other	Count	17	0	0	0	0
Schools	Count	1	0	0	0	0
Post Offices	Count	1	0	0	0	0
Emergency Services	Count	2	0	0	0	0
Transportation						
Roads	Feet	119,994	0	0	0	238
Rail	Feet	8,503	0	0	0	183
Bridges	Count	4	0	0	0	2
Recreation, and Public Access						
Beaches	Acres	5.8	0.4	0.5	1.5	5.5
Coastal Access Points	Count	12	0	0	1	4
Parking Lots	Acres	4.1	0	0	0	0
Coastal Trail	Feet	9,543	0	0	0	0
Water and Utility Infrastructure						
Storm Drain Structures	Count	667	2	2	2	13
Storm Drain Conduits	Feet	50,173	17	21	34	342
Sewer Structures	Count	472	0	0	0	1
Sewer Conduits	Feet	118,365	0	0	0	552
Water Mains	Feet	144,206	0	0	0	564
Natural Resources						
National Wetlands	Acres	16	1.6	1.6	2.1	10.3

5.3 Vulnerability to Coastal Storm Flooding

Coastal flooding due to high winter waves has long been a hazard to Capitola. The ESA hazard models estimated that both wave run-up force and the height of flood water within low lying areas may be greater over time. Infrastructure closest to the beach will continue to be impacted by the force of waves, the deposition of sand, kelp and other flotsam, and by the floodwaters that do not drain between waves. Infrastructure further inland is most vulnerable to flooding by a combination of ocean and riverine sources (Section 5.4). Table 8 outlines the projected impacts to assets within Capitola from coastal storm flooding.

Land Use and Buildings

Infrastructure projected to be at risk from coastal flooding by 2030 is similar to those properties currently vulnerable. In total, 27 residential and 84 commercial buildings may be vulnerable to storm flooding by 2030 (22 more than presently).

Coastal storm flooding may pose risks to 84 additional buildings by 2060 than are projected at risk in 2030, including the Capitola fire station. By 2100, even more structures may be at risk of flooding (48 additional residential and 11 commercial). Before 2060, structures adjacent to the shore may see more frequent and severe wave damage due wave run-up encroachment inland while infrastructure location remains static (Figure 10). However, for the 2060 and 2100 planning horizons projected flood zones may be misleading. For instance, cliff areas where coastal armoring is not replaced by 2060 are assumed to retreat as projected in the erosion hazard models (see Section 5.5). Houses within this erosion zone will be lost prior to this area becoming vulnerable to flooding in 2060.

Tidal inundation and wave run-up in Capitola Jan, 2008 (Photo: Patrick Barnard, USGS Santa Cruz)

Transportation

For the 2030 planning horizon, six local roadways (Esplanade Rd, San Jose Ave, Riverview Ave, Capitola Ave, Monterey Ave, and California Ave) are projected to be at risk of flooding during winter storms, restricting crosstown traffic and totaling more than 2,700 feet. Almost twice as many feet of roadway may be flooded by 2060.

Recreation and Public Access

Most of Capitola beach currently floods and may continue to flood during winter storms. Most coastal access ways may be unavailable during storms. Areas of Esplanade Park and Soquel Creek Park may be impacted by coastal storm flooding as early as 2030.

Water and Utilities

Currently, more than 70 storm drains are projected to be impacted by coastal storm flooding, with an additional 19 storm drains projected by 2030. Additionally, four of the storm drain discharge points along the Esplanade that provide coastal storm flood relief, may be compromised. Significant amounts of subsurface water and wastewater infrastructure is located within the flood zones and may see impacts from periodic flooding.

Natural Resources

Few natural resources are vulnerable to flooding by 2100 other than 6.8 acres of Soquel Creek, most of which is currently vulnerable.

Figure 10. Buildings Vulnerable to Coastal Storm Flooding

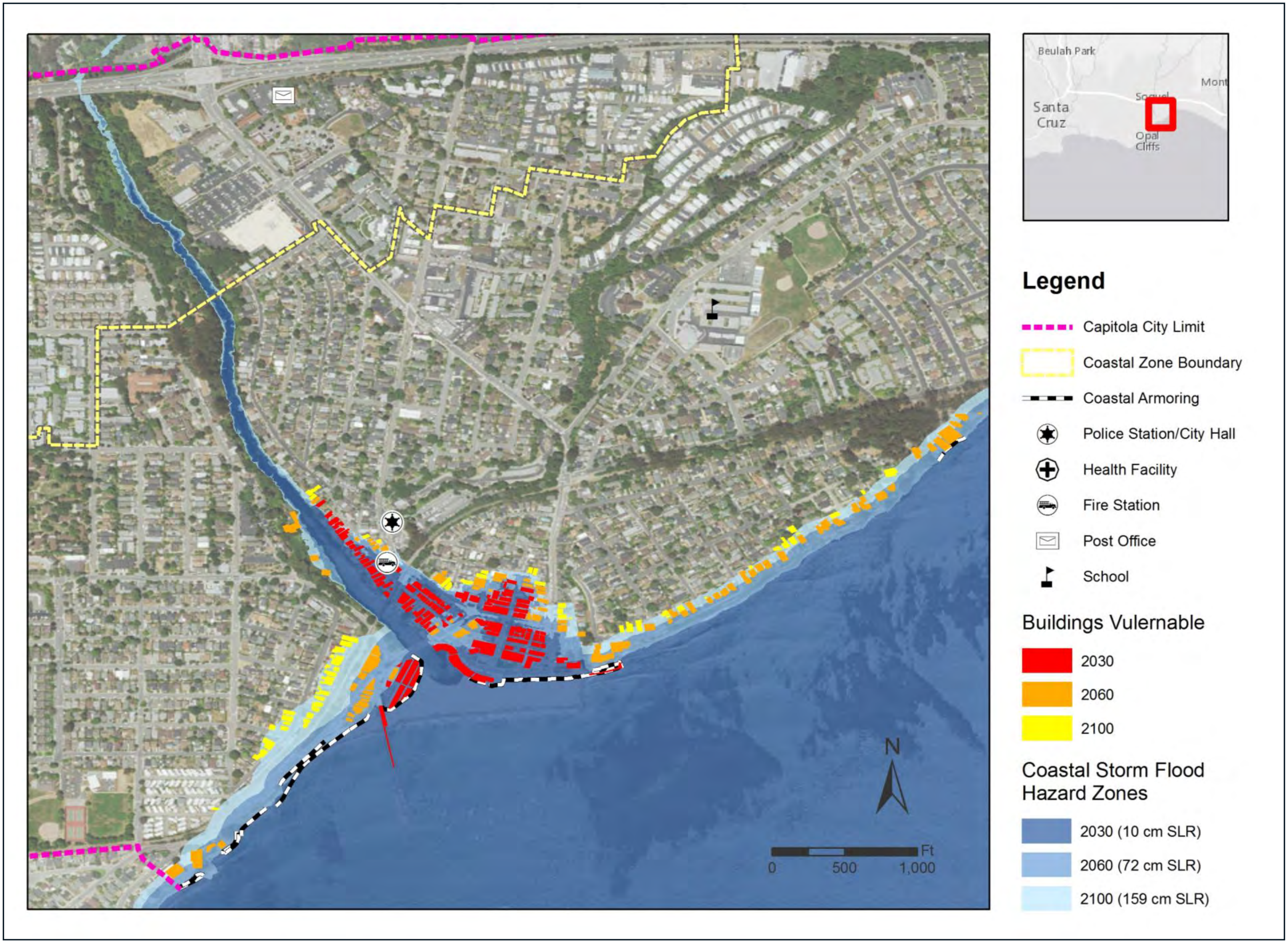


Table 8. Summary of Assets Vulnerable to Coastal Storm Flooding

ASSET	UNIT	TOTAL	2010 (WITH ARMOR)	2030 (WITH ARMOR)	2060 (NO ARMOR)	2100 (NO ARMOR)
Land Use and Buildings						
Total Buildings	Count	3,025	94	118	201	263
Residential	Count	2,600	24	27	66	114
Commercial	Count	326	65	84	122	133
Public	Count	67	4	4	6	7
Visitor Serving	Count	15	1	3	7	9
Other	Count	17	0	0	0	0
Schools	Count	1	0	0	0	0
Libraries	Count	0	0	0	0	0
Post Offices	Count	1	0	0	0	0
Emergency Services	Count	2	0	0	1	1
Transportation						
Roads	Feet	119,994	2,014	2,759	6,772	8,950
Rail	Feet	8,503	229	291	1,107	3,261
Bridges	Count	4	2	2	3	3
Recreation and Public Access						
Beaches	Acres	5.8	5.8	5.8	5.8	5.8
Coastal Access Points	Count	12	10	10	12	12
Parking Lots	Acres	4.1	0.4	0.5	1.3	1.7
Coastal Trail	Feet	9,543	0	0	1,428	1,684
Water and Utility Infrastructure						
Storm Drain Structures	Count	667	74	93	128	135
Storm Drain Conduits	Feet	50,173	2,429	3,125	5,007	5,869
Sewer Structures	Count	472	19	24	51	70
Sewer Conduits	Feet	118,365	4,741	5,916	12,925	16,219
Water Mains	Feet	14,4206	4,127	6,128	9,870	11,238
Culverts	Count	3	0	0	0	0
Natural Resources						
National Wetlands	Acres	16	5.2	5.3	6.3	6.8

5.4 Vulnerability to River Flooding

Storm intensity is predicted to increase within Santa Cruz County through 2100. These more infrequent but intense rain events are predicted to cause rivers and creeks to rise rapidly leading to localized flooding and erosion. This study evaluated the combined threats of higher ocean levels during storm events and higher river discharge caused by excessive localized rain events within the Soquel watershed. This fluvial analysis generated an additional hazard zone for each time horizon that was then used to evaluate structures vulnerable to this river flooding. The projected increase in fluvial discharge within Soquel Creek due to more intense rainfall during storms used for this analysis is outlined in Table 9.[28] River flooding height due to more intense rainfall is estimated to increase by approximately 2 feet (increasing depth to 8.5 feet in parts of downtown) between 2010 and 2060. Table 10 outlines the projected impacts to assets within Capitola from fluvial flooding.

Table 9. Increase in 100-year Discharge for Soquel Creek Relative to Historic Period (1950-2000)

EMISSIONS SCENARIO	2030	2060	2100
Medium (RCP 4.5 5th percentile)	13%	15%	20%
High (RCP 8.5 90th percentile)	62%	68%	95%

Land Use and Buildings

Large areas of Capitola and Soquel are vulnerable to river flooding along Soquel Creek, Capitola Village and the Nob Hill shopping center (Figure 11). Fifty-nine residential properties (along Riverview Dr. and within Capitola Village) are currently projected to be vulnerable to flooding from the combined threat of high river levels during high tide events. In total, 84 more buildings are identified as at risk of river flooding by 2030 than identified within the coastal flooding layer for 2030.

Transportation

Twice the length of roadway is projected to be at risk of flooding from the Soquel River than is projected to be at risk from coastal storm flooding alone. Access to Highway 1 may be compromised due to flooding of on-ramps by 2100.

Recreation and Public Access

River flooding poses a lesser risk to coastal access but may impact parks adjacent to Soquel Creek such as Soquel Creek Park. Peery Park, although adjacent to the Soquel Creek, is at an elevation where it should not be impacted.

[28] ESA. 2016. Monterey Bay Sea Level Rise: Climate Change Impacts to Combined Fluvial and Coastal Hazards.

Water and Utilities

Currently 149 storm drains are projected to be impacted by Soquel Creek flood waters (twice that of coastal flooding) and an additional 22 storm drains may be compromised by the higher ocean and river elevation by 2030. Several drains that currently provide flood relief may be further compromised due to higher river water levels and may become conduits for inland flooding by 2060 to areas isolated from current flooding.

Natural Resources

Wetland and Riparian resources along Soquel Creek are identified within the fluvial hazard layer as early as 2030 but are likely resilient to these hazards.

Capitola Avenue flooded from Noble Gulch Creek on Saturday March 26, 2011 (Photo: Santa Cruz Sentinel)

Figure 11. Buildings Vulnerable to River (Fluvial) Flooding

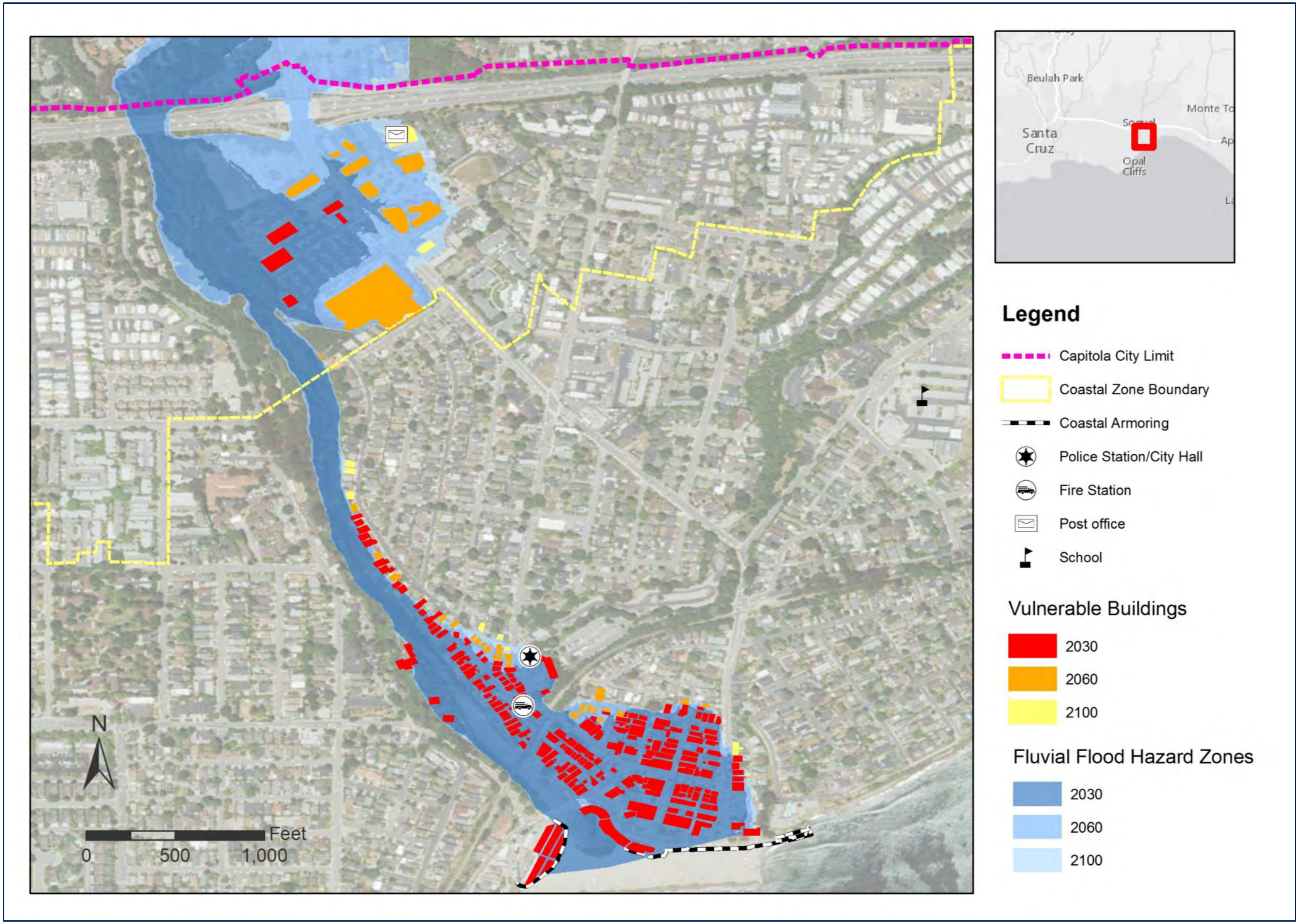


Table 10. Summary of Assets Vulnerable to River (Fluvial) Flooding

ASSET	UNIT	TOTAL	2010	2030	2060	2100
Land Use and Buildings						
Total Buildings	Count	3,025	194	202	238	248
Residential	Count	2,600	59	62	78	82
Commercial	Count	326	130	134	154	160
Public	Count	67	4	4	4	4
Visitor Serving	Count	15	1	2	2	2
Other	Count	17	0	0	0	0
Schools	Count	1	0	0	0	0
Post Offices	Count	1	0	0	0	1
Emergency Services	Count	2	1	2	2	2
Transportation						
Roads	Feet	119,994	6,128	6,783	9,932	10,889
Rail	Feet	8,503	428	431	435	435
Bridges	Count	4	3	3	3	3
Recreation and Public Access						
Beaches	Acres	5.8	0.8	0.8	0.8	0.8
Coastal Access Points	Count	12	2	2	2	2
Parking Lots	Acres	4.1	0.6	0.6	0.7	0.8
Coastal Trail	Feet	9,543	0	0	0	0
Water and Utility Infrastructure						
Storm Drain Structures	Count	667	149	171	213	214
Storm Drain Conduits	Feet	50,173	7,319	8,068	10,685	10,836
Sewer Structures	Count	472	44	45	58	61
Sewer Conduits	Feet	118,365	8,846	9,703	12,301	12,854
Water Mains	Feet	144,206	11,078	11,911	14,539	15,326
Natural Resources						
National Wetlands	Acres	16	7.2	7.2	7.3	7.3

5.5 Vulnerability to Erosion

Photo Source: Timeline of Natural Hazard Events Impacting the City of Capitola, City of Capitola

Capitola is vulnerable to impacts from coastal erosion along the cliff edges west and east of downtown. There are rip-rap and concrete structures in place along the base of portions of these cliffs that have reduced bluff erosion significantly. If these structures are not upgraded or replaced they may continue to decay as climate change stresses add to current intensity of storm damage. Table 11 outlines the assets vulnerable to beach and cliff erosion. Project specific studies however may be needed to better estimate site specific erosion rates.

Land Use and Buildings

Several residential and commercial structures are currently threatened by coastal erosion in areas where seawalls or other structures are not present. Five buildings are at risk of bluff erosion currently and this may increase to 8 properties by 2030. The number of properties vulnerable to erosion may increase significantly (32) by 2060 as new areas not protected by armoring begin to become vulnerable. An additional 100 properties are at risk by 2060 if current coastal armoring is not upgraded or replaced. A total of 98 homes are at risk of being lost by 2100 along Grand Avenue and Cliff Drive if coastal armoring is allowed to deteriorate or is removed. Bluff erosion is also predicted for the base of the Wharf and the Venetian Courts if sea walls are not maintained or rebuilt. As many as 221 properties are within the bluff erosion zone by 2100 if protective structures are not maintained, expanded or replaced.

Although many of these homes are more than 200 feet from the current bluff edge, the models highlight the significant erosion risk to this area in the future if existing coastal armoring fails. If bluff retreat is halted by replacing coastal armoring, however, many beach access ways and most of Capitola beach may be lost (Figure 12) as ocean tides progress inward towards these stationary structures (aka Coastal Squeeze).

Transportation vulnerable to erosion

Lateral road access along the east side of town has already been lost due to cliff erosion. Cliff Drive remains a key western access road into the downtown area and is vulnerable to cliff erosion by 2060 if protective measures are not implemented. Additional transportation infrastructure that is in jeopardy include the public access way along what remains of Grand Avenue and the rail corridor which was recently purchased by the county to provided alternate transportation corridor throughout the county.

Recreation and Public Access

Cliff erosion threatens numerous parks and visitor serving resources within Capitola. Five coastal access points are currently vulnerable to bluff erosion and by 2060 all access ways may be at risk unless coastal protection is updated. Loss of beach area (95% by 2100) is reported within Section 5.4 (Tidal Inundation).

Water and Utilities

A significant number of storm water and wastewater structures are currently vulnerable to erosion, when accounting for coastal protective structures. The number of structures and feet of pipe at risk increase significantly by 2060 if coastal armoring is not maintained or replaced. Sewer and water mains are vulnerable during all time horizons to failure due to coastal erosion.

Natural Resources

Approximately half of the wetland habitat along Soquel Creek is vulnerable to erosion by 2100.

Figure 12. Buildings Vulnerable to Erosion

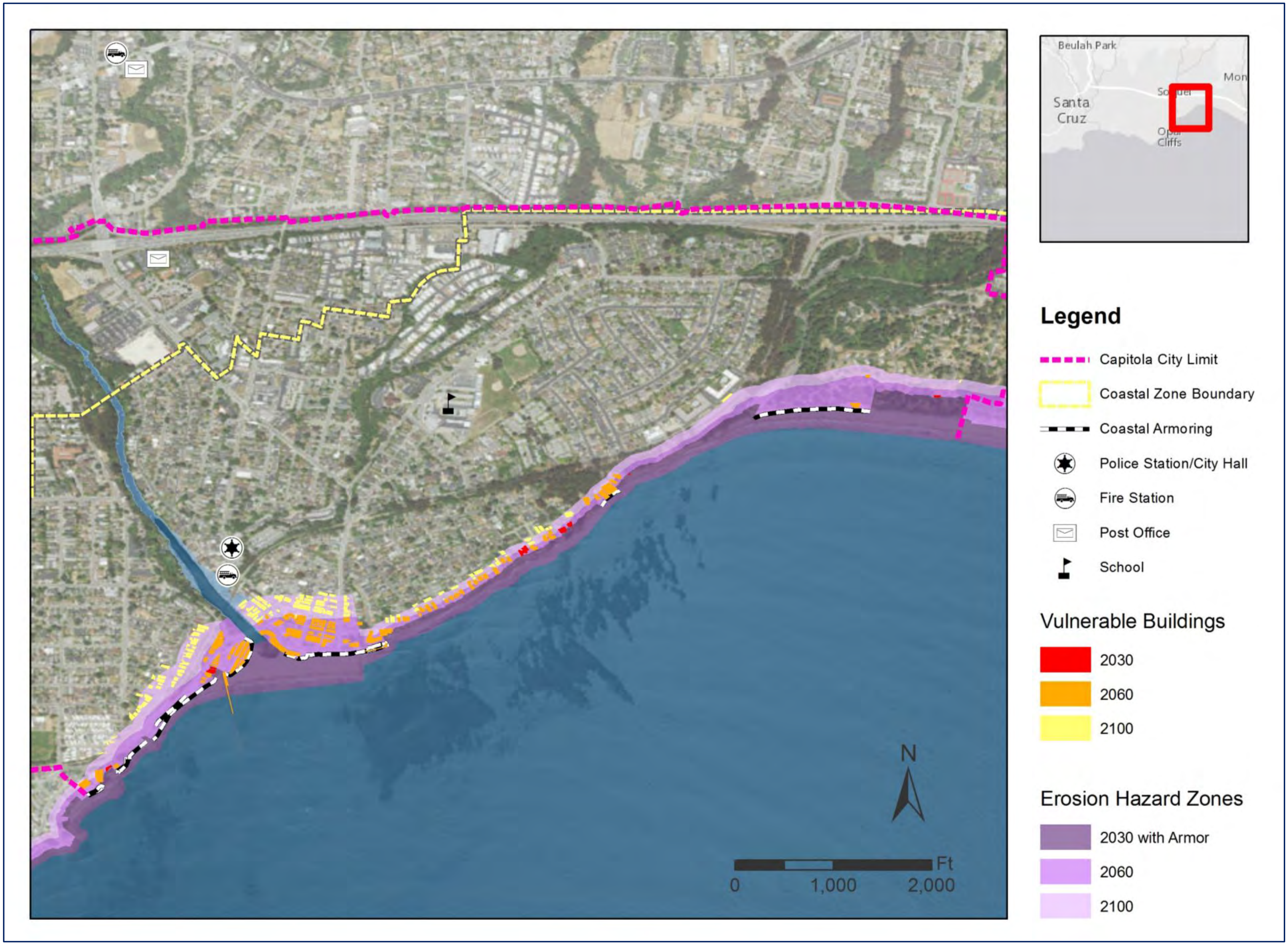


Table 11. Summary of Assets Vulnerable to Erosion

ASSET	UNIT	TOTAL	2010 (WITH ARMOR)	2030 (WITH ARMOR)	2060 (NO ARMOR)	2100 (NO ARMOR)
Land Use and Buildings						
Total Buildings	Count	3,025	5	8	103	221
Residential	Count	2,600	0	3	39	98
Commercial	Count	326	2	2	52	105
Public	Count	67	1	1	6	10
Visitor Serving	Count	15	2	2	6	8
Other	Count	17	0	0	0	0
Schools	Count	1	0	0	0	0
Post Offices	Count	1	0	0	0	0
Emergency Services	Count	2	0	0	0	0
Transportation						
Roads	Feet	119,994	152	247	4,140	8,891
Rail	Feet	8,503	0	0	986	3,142
Bridges	Count	4	0	0	0	1
Recreation and Public Access						
Beaches	Acres	5.8	5.8	5.8	5.8	5.8
Coastal Access Points	Count	12	5	8	12	12
Parking Lots	Acres	4.1	0.1	0.0	1.4	1.9
Coastal Trail	Feet	9,543	3	32	1,550	2,404
Water and Utility Infrastructure						
Storm Drain Structures	Count	667	8	14	68	114
Storm Drain Conduits	Feet	50,173	387	500	2,914	4,568
Sewer Structures	Count	472	3	3	38	63
Sewer Conduits	Feet	118,365	892	950	9,808	17,192
Water Mains	Feet	144,206	756	1,038	6,966	13,898
Natural Resources						
National Wetlands	Acres	15.6	0.9	1.2	8.3	8.3

5.6 Summary of Specific Vulnerable Assets

Venetian Court

The Venetian court hip-wall provides protection from mild winter storms and maintains a sand free walkway adjacent to the beach. Currently the beach and walkway are approximately the same elevation on opposite sides of the wall. As ocean encroachment progresses, the wall will provide a hard backshore resisting the migration of the beach inward but may provide less protection from wave overtopping and wave damage.

Capitola Esplanade

The Esplanade walkway provides a defined boundary between the urban area and the beach. The hip-wall adjacent to the walkway provides a key protective function during winter high wave events, reducing wave impacts and flooding to the Village. The Esplanade includes several public access points that can be blocked off during winter storms. There are discharge holes that provide minimal drainage and several storm drain discharge points seaward of the wall. As wave height and sea levels rise, the hip-wall may provide less and less protection to the commercial district along the Esplanade. Wave run-up energy may be more significant in the future, leading to greater volumes of water overtopping the wall, causing additional flooding downtown. Greater wave heights may possibly lead to greater structural impacts from water and debris. The Esplanade may need to be realigned landward in the future if the community wishes to maintain beach width and storm protection capacity.

Historic Districts

All three of the designated Historic Districts in Capitola are projected to be impacted by coastal climate change hazards. The proximity of the Venetian Historic District to coastal hazards leaves it vulnerable to coastal erosion, coastal storm flooding and wave impacts. The Old Riverview Historic District is adjacent to Soquel Creek making it most vulnerable to river flooding. Six Sisters/Lawn Way Historic District lies within the low-lying areas of Capitola Village and is vulnerable to coastal wave impacts and storm flooding, river flooding, and erosion after 2030 if coastal armoring begins to fail.

River walkway

The river walkway parallels the east side of Soquel Creek from the Stockton St. Bridge inland to the Noble Creek culvert near Riverview and Blue Gum avenues. The walkway provides a valuable public access way along the river and a pedestrian link between the residential area and the coast. Presently there are private patios and yards westward of the walkway. The yards and the walkway are approximately 3 feet above base flow within the creek. During extreme river flow conditions, this area is prone to flooding. In addition, a number of storm drains flow under the walkway and discharge to the creek. Flood water depths along the river walkway are estimated to be as much as 8 feet by 2060.

Parking lots and public access ways

Parking spaces along the Esplanade are already vulnerable to periodic flooding during storm events. By 2030 such flooding may occur more often. Beach and Village Parking Lots number 1 and 2 near City Hall are also vulnerable to river flooding. A number of public access ways are vulnerable to flooding due to higher river levels, wave impacts and coastal erosion. By 2060 use of all 12 public access ways may be periodically restricted due to various coastal climate risks.

Emergency services and city hall

The Capitola fire station is currently at risks of coastal storm flooding and river flooding (FEMA flood maps). City Hall and the police station, which are currently located in the 100-year FEMA flood zone, are vulnerable to river flooding by 2030.

Schools

No schools are at risk.

Storm drains

Capitola already experiences periodic flooding of the downtown during winter storms. During these storms the storm drain system may back up or be overwhelmed when submerged during ocean storms and high river elevations. These submerged discharge pipes may also become a conduit for inland flooding, bypassing coastal protection structures. Field surveys were completed to document the surface elevation of storm drains and drop inlets throughout the village. Storm drain elevations were correlated with tidal water height for each planning horizon to document when these storm drains may act as conduits for inland flooding (Figure 13). By 2060, five storm drain drop boxes located within city streets may be below high tide elevations, posing a monthly flood risk to these areas of the community. Some of these storm drains are inland of the Rising Tides hazard zones, suggesting that storm drains may prove to exacerbate tidal flooding by mid-century.

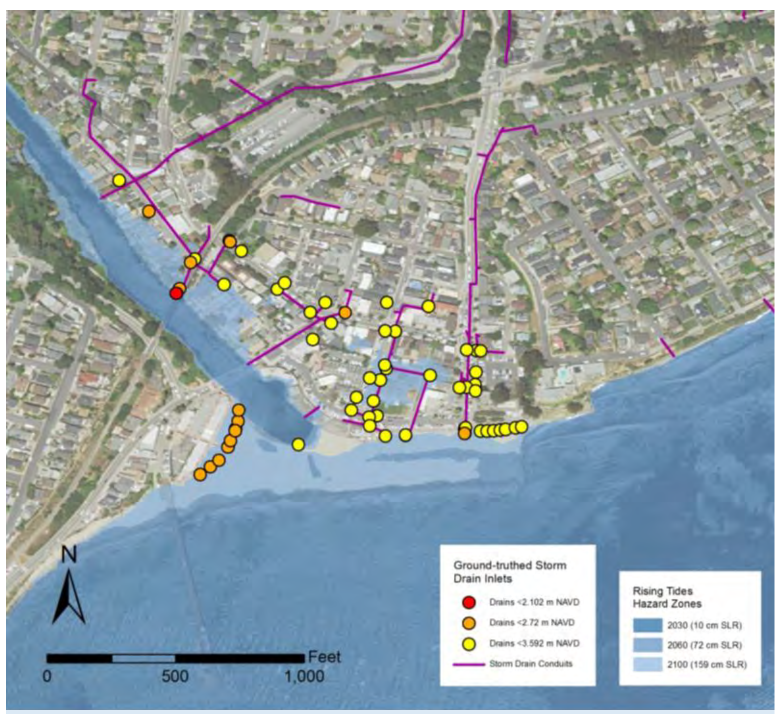


Figure 13. Storm drains with elevations within the projected tidal range for each time horizon

Table 12 further outlines the earliest time horizon that specific assets may become vulnerable to each of the coastal hazards.

Table 12. Important Assets Vulnerable to Coastal Hazard Impacts

FACILITY	TYPE	COASTAL HAZARD IMPACT	IMPACT THRESHOLD
Fire Station	Emergency	Coastal storm flooding River flooding	2060 2030
Police Station	Emergency	River flooding	2030
City Hall/ Emergency Operations	Public	River flooding	2030
Post office	Government	River flooding	2100
Capitola Historical Museum	Public/Visitor Serving and Historic District	River flooding	2030
Capitola Venetian (and Historical District)	Visitor Serving	Coastal storm flooding River flooding Erosion Rising Tides	2010 2010 2060 2100
Capitola Wharf	Public/Visitor Serving	Coastal storm flooding Erosion	2030 2060
Soquel Creek Park	Park	Coastal storm flooding River flooding Rising tides	2010 2030 2100
Esplanade Park	Park	Coastal storm flooding Erosion	2010 2030
Capitola Beach	Beach	Coastal storm flooding Erosion River flooding	2010 2030 2030
Beach access at Esplanade	Coastal Access	Coastal storm flooding Erosion Rising tides River flooding	2010 2030 2060 2030
Cliff Drive beach access	Coastal Access	Erosion	2060
Coastal Trail	Trail	Coastal storm flooding Erosion	2060 2060
Esplanade parking lot	Parking lot	Coastal storm flooding Erosion River flooding	2010 2060 2030
Wharf Rd parking lot	Parking lot	Coastal storm flooding Erosion	2030 2060

FACILITY	TYPE	COASTAL HAZARD IMPACT	IMPACT THRESHOLD
Cliff Drive parking	Parking lot	Erosion	2060
Prospect Avenue parking	Parking lot	Erosion	2100
City Hall parking lot	Parking lot	River flooding	2030
Esplanade Road	Road	Coastal storm flooding Erosion River flooding	2010 2060 2030
Cliff Drive	Road	Erosion	2060
Wharf Avenue	Road	Coastal storm flooding	2030
Grand Avenue	Road	Erosion	2030
Prospect Drive	Road	Erosion	2100
Stockton Bridge	Bridge	Erosion	2060
Soquel Creek	Creek/Wetland	Coastal storm flooding Rising Tides	2010 2030
Six Sisters/Lawn Way Historic District	Historic District	Coastal storm flooding Erosion River flooding Rising Tides	2010 2060 2030 2100
Old Riverview Historic District	Historic District	Coastal storm flooding Erosion River flooding Rising Tides	2010 2060 2010 2100

CUMULATIVE RISKS TO CAPITOLA FROM COASTAL CLIMATE CHANGE

This study suggests that by 2030 flooding during winter storms may increase in intensity as ocean wave run-up energy and increases in river discharge act together. Coastal erosion currently threatens five unprotected structures in Capitola including two commercial properties (Figure 12). By 2030 eight structures may be at risk including two residential properties if current coastal protection structures remain in place but no new structures are constructed. A significant number of storm, water and wastewater structures and many feet of pipe are vulnerable from coastal erosion during all time horizons. Cliff Drive remains a key western access road into the downtown area and is vulnerable to cliff erosion by 2060 if protective measures are not replaced. A table of key facilities at risk of various hazards and time horizons (Table 12) is intended to aid adaptation planning. This study confirms that coastal flooding may remain a primary risk for Capitola. This study also finds that river flooding may be of greater risk to the community than previously realized and that sea level rise may greatly impact the beach and public areas by 2100 unless retreat policies are adopted.

6. Economics of Future Climate Risks

The costs to repair damage caused by wave impacts and flooding can be quite large. For example, the Capitola Public Works Director estimated that approximately $500,000 worth of damage to city property, and several million dollars' worth of damage to the city-owned Pacific Cove Mobile Park occurred as a result of the 2011 flood event in Capitola Village.

The protection of structures and properties within the coastal and fluvial flood hazard zones is a high priority for the community. Understanding the cumulative value of the properties and infrastructure that are vulnerable to the identified hazards may aid the selection of protection and adaptation strategies, and help to direct limited public and private resources towards the most pragmatic and effective actions. Longevity of various protection and adaptation strategies, the costs to construct and the future reliability of coastal infrastructure should all be weighed before response strategies are selected.

Property valuation of vulnerable properties and infrastructure

Some studies (Santa Cruz County Hazard Mitigation Plan[29] and Coastal Regional Sediment Management Plan for the Santa Cruz Littoral Cell[30]) have estimated future property loss separately for building values and land values. This technique allows impacts to be calculated separately for structural impacts (due to coastal and river flooding) and property loss (due to coastal erosion and sea level rise). Unfortunately, the property value estimates used within these studies are linked to County assessor data which are often much lower than current appraised value and thus underrepresent real economic risks.

A simple economic estimation of costs of the projected climate hazards was completed to provide rough estimates of property loss for each time horizon. The average property value for residential and commercial properties within Capitola were estimated (Table 13) and used to quantify the cumulative economic impact of replacing or relocating these buildings and services. The Capitola Hazard Mitigation Plan identified costs to replace or move critical municipal infrastructure found to be at risk of various natural hazards (not including price of property to relocate).

[29] County of Santa Cruz. 2015. Santa Cruz County Local Hazard Mitigation Report
[30] United States Army Corps. 2015. Coastal Regional Sediment Management Plan for the Santa Cruz Littoral Cell, Pillar Point to Moss Landing. Prepared for The California Coastal Sediment Management Workgroup.

Table 13. Property valuation data sources for economic analysis

ASSET	VALUATION	SOURCE
Residential properties	$930,000	Capitola average sale price[31]
	$2,100,000	Capitola beach front sale price[32]
	$662,631	US Census[33]
	$809,860	Santa Cruz Littoral Cell report[34]
	$1,400,000	Pacific Institute Report 2009[35]
	$987,727	SCC-LHMP fire residential[36]
	$958,043	**Average of studies**
Commercial properties	$145,005	SCC-LHMP fire commercial
	$2,600,000	Average LoopNet Listings[37]
Public	$4,000,000	Capitola Local Hazard Mitigation Plan[38]
Emergency Services	$1,500,000	Capitola Local Hazard Mitigation Plan
Roads /ft	$280	TNC 2016[39]
Rail /ft	$237	SJVR Business Plan[40]
Storm Drain conduit /ft	$1,080	TNC 2016
Waste Water conduit /ft	$1,080	TNC 2016
Drinking Water conduit /ft	$189	TNC 2016

[31] Zillow. Capitola. http://www.zillow.com/capitola-ca/ (Dec 2016)

[32] Ibid.

[33] United States Census Bureau. Capitola Quick Facts. http://www.census.gov/quickfacts/table/PST045215/0611040 (Dec 2016)

[34] United States Army Corps. 2015. Coastal Regional Sediment Management Plan for the Santa Cruz Littoral Cell, Pillar Point to Moss Landing.

[35] Heberger M, H Cooley, P Herrera, PH Gleick, E Moore. 2009. The Impacts of Sea-Level Rise on the California Coast. Prepared by the Pacific Institute for the California Climate Change Center.

[36] County of Santa Cruz. 2015. Santa Cruz County Local Hazard Mitigation Report

[37] LoopNet. Capitola. http://www.loopnet.com/for-sale/capitola-ca/?e=u (Dec 2016)

[38] City of Capitola. 2014. Capitola Local Hazard Mitigation Plan

[39] Leo, K.L., S.G. Newkirk, W.N. Heady, B. Cohen, J. Calil, P. King, A. McGregor, F. DePaolis, R. Vaughn, J. Giliam, B. Battalio, E. Vanderbroek, J. Jackson, D. Revell. 2017. Economic Impacts of Climate Adaptation Strategies for Southern Monterey Bay. Technical Report prepared for the California State Coastal Conservancy by The Nature Conservancy. SCC Climate Ready Grant #13-107.

[40] Railroad Industries Incorporated. 2011. Business Plan for Operations of the SJVR in Fresno County. Prepared for Fresno Council of Governments

Currently $211 million in property and infrastructure are vulnerable to the combined hazards of coastal climate change within the City of Capitola (Table 14). By 2030, the total value increases to $227 million in property and infrastructure. By 2030 $62 million (26% of potential losses) in residential properties are at risk. Almost $130 million in commercial properties (57% of potential losses) are vulnerable to 2030 hazards. Approximately $35 million in public properties and infrastructure are within the hazard zone for 2030. Waste water and storm drain conduit are the infrastructure at greatest risk of projected hazards within the City.

Table 14. Total Value (2016 dollars) of Capitola Properties at Risk

ASSET	VALUE PER UNIT	2010 (WITH ARMOR)	2030 (WITH ARMOR)	2060 (NO ARMOR)	2100 (NO ARMOR)
PROPERTIES					
Residential	$930,000	$56,730,000	$62,310,000	$104,160,000	$162,750,000
Commercial	$930,000	$124,620,000	$128,340,000	$154,380,000	$159,960,000
Public	$500,000	$4,500,000	$7,500,000	$12,500,000	$17,500,000
Emergency Services	$2,000,000	$0	$2,000,000	$4,000,000	$4,000,000
Property losses		*$185,850,000*	*$200,150,000*	*$275,040,000*	*$344,210,000*
TRANSPORTATION					
Roads (ft)	$280	$1,812,440	$1,963,360	$3,728,480	$4,798,640
Rail (ft)	$280	$118,160	$118,160	$581,280	$913,080
Transportation losses		*$1,930,600*	*$2,081,520*	*$4,309,760*	*$5,711,720*
WATER AND UTILITY INFRASTRUCTURE					
Storm Drain conduit (ft)	$1,080	$8,678,466	$9,376,932	$12,807,727	$12,945,909
Waste Water conduit (ft)	$1,080	$12,872,500	$12,872,500	$21,839,205	$28,457,898
Drinking Water conduit (ft)	$189	$2,603,030	$2,603,030	$3,666,667	$4,420,265
Utility Losses		*$24,153,996*	*$24,852,462*	*$38,313,598*	*$45,824,072*
TOTAL COMBINED LOSSES		**$211,934,596**	**$227,083,982**	**$317,663,358**	**$395,745,792**

Property values within the 2060 coastal climate hazard zone increase to $317 million unless current coastal armoring is replaced and new structures are constructed to protect infrastructure vulnerable to 2060 hazards. If almost one mile of coastal armoring within the city is upgraded or replaced before 2060 (at an estimated cost of $20-52 million to construct), the total value of properties at risk is reduced by relatively small $56 million. The total value of private residential properties at risk increases to $162 million (41% of all assets at risk) by 2100.

Many of the properties identified during each time horizon are vulnerable to multiple hazards (i.e. erosion and coastal flooding). Depending on the engineering complexity and costs of replacing these coastal protection structures, and the secondary environmental and economic impacts of such construction, protecting all of the identified properties is likely cost prohibitive.

This initial economic evaluation highlights the need for constructive discussions between city decision makers, public citizens and private property owners to establish protection and adaptation policies that fairly allocate costs of protection and adaption efforts and that weigh public and private property concerns equitably.

A more comprehensive economic analysis that accounts for relative scale of property damage for each projected hazard (i.e. temporarily flooded or total loss of property) is possible with the current data but is beyond the scope of this study. Using the compiled hazard and vulnerability data generated by this project, coastal armor construction costs and the secondary environmental and economic impacts resulting from constructed structures can be compared with costs to move structures and losses resulting from abandoning vulnerable structures. Together these data can be used to generate temporal cost/benefit/consequence scenarios for each section of coastline and each time horizon.

7. Adaptation

The risks associated with each of the modeled coastal processes (wave run-up and overtopping, coastal erosion, rising tides and fluvial flooding) threaten various types of coastal infrastructure differently. Selection of adaptation options must be driven by consideration of the possible damage of each risk and the frequency of reoccurring impact. Unfortunately, the models used for this report estimate the likelihood of each hazard for each of three time horizons, but do not report the likely frequency.

Wave and fluvial flooding can damage buildings, and temporarily restrict use of public amenities, make storm drains ineffective and limit the use of roads and walkways. Storm flood risks represent periodic impacts and require periodic responses.

Cliff erosion and flooding during high tides are permanent or reoccurring impacts that can lead to a complete loss of infrastructure and use of those properties. Such hazards require extensive rebuilding or reinforcement, a change in use of the property, or abandonment of the property entirely.

Future investments in the protection of public and private structures need to be weighed by city staff and property owners against the property’s value, construction costs of selected adaptive measures, limitations provided by regulatory agencies, and the expected effectiveness and longevity of the adaptation strategy selected. Secondary implications of adaptation options should also be considered, including restrictions to coastal access, loss of beach and the visual degradation of the coastline. This adaptation analysis highlights the need for long-range coastal management planning to best balance property values and adaptation measures costs with the resulting changes to the public beach and coastline.

7.1 Current Strategies Used by the City of Capitola

Capitola currently relies on various storm protection strategies to reduce winter storm flooding. These include building sand berms on the beach to reduce wave impacts (Figure 14), placement of flashboards at access points in the Esplanade hip-wall, sandbags within door and access ways, opening Soquel Creek to the ocean and ensuring that storm drains have been services and are functioning properly. Capitola has also installed 1.2 miles of sea walls along the coastline to reduce cliff erosion and flooding during winter storms. Residents and businesses in Capitola prepare for impacts by boarding doors and windows and placing sand bags.

Figure 14. Berms built at Capitola Beach help to decrease coastal flooding of the Village (Photo: R. Clark)

During storms, City staff provides response services including visual monitoring of creeks and storm drain inlets throughout the city and manned response with equipment including pumps and generators as needed to address localized flooding. Once storms have ended, cleanup of sand and debris and repair of damaged infrastructure begins. Response and municipal repair costs for the 2014-2015 El Niño winter totaled an estimated $20,000 to date with another $130,000 pending.

Costs of storm response for the 2016-2017 winter La Niña are not tallied as of completion of this report but are expected to be significantly higher. Early estimates for 2017 road repairs for Santa Cruz County exceed $30 million.

Strategies listed within existing Capitola Plans

General Plan

On June 26 2014, the Capitola City Council adopted the General Plan Update to replace the City's previous 1989 General Plan. The General Plan Update provides new goals and policies to promote sustainability, improve protections of residential neighborhoods and historic resources, and enhance economic vitality.[41] Among the Guiding Principles described within the General Plan for Environmental Resources is to:

> *"Embrace environmental sustainability as a foundation for Capitola's way of life. Protect and enhance all natural resources—including the beaches, creeks, ocean, and lagoon—that contribute to Capitola's unique identify and scenic beauty. Reduce greenhouse gas emissions and prepare for the effects of global climate change, including increased flooding and coastal erosion caused by sea-level rise."*

Hazard Mitigation Plan

The 2014 Capitola Local Hazard Mitigation Plan[42] evaluates risks from river and coastal flooding and makes programmatic and project related recommendations to address these risks. A number of those recommended actions will directly address the risks identified within this report (Table 15).

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[41] City of Capitola. 2014. Capitola General Plan.

[42] RBF and Dewberry. 2013. Capitola Local Hazard Mitigation Plan

Table 15. City of Capitola Local Hazard Mitigation Plan Recommendations

ACTIONS WITHIN HAZARD MITIGATION PLAN THAT ADDRESS PREDICTED CLIMATE RISKS
▪ Evaluate the likelihood of debris flow impacts to the Stockton Avenue bridge during a catastrophic flooding event. ▪ Relocate or elevate critical facilities (e.g. City hall, police, fire, etc.) above the level of the 100-year flood elevation. ▪ Assist in the planning and/or improvement of infrastructure (sewers) and facilities to help minimize flooding impacts, particularly in critical flood-prone areas (e.g. Capitola Village). ▪ Continually monitor and review FEMA's National Flood Insurance Program (NFIP) requirements to ensure the City's floodplain management regulations are in compliance. ▪ Review and update the city's existing ordinances as they relate to storm / flooding hazards, consistent with the risks identified in this LHMP. ▪ Work in close coordination with state and local agencies and organizations to protect and preserve the coastline and its coastal bluffs through restoration efforts to help ensure safe coastal access and the protection of adjacent infrastructure and facilities. These efforts may include beach replenishment, coastal bluff protection, seawall construction, and other appropriate measures. ▪ Support the timely and accurate update of tsunami inundation maps within the Monterey Bay area. Then integrate the new tsunami inundation maps into the risk assessment of this Local Hazard Mitigation Plan ▪ Continue to update and enhance mapping data and the City's GIS for all hazards *(including coastal climate change).* ▪ Integrate the results of the Monterey Bay Sea Level Rise Study (this report) into the Local Hazard Mitigation Plan risk assessment and the General Plan Safety Element. ▪ As part of the General Plan Update process, develop a plan to address climate change/ climate adaptation issues within the City and its surroundings. ▪ Protect and preserve the coastline through permit review and continue to review coastal development for conformance with applicable City regulations (e.g. geologic, flood). ▪ Review and update the city's existing ordinances as they relate to hazards and risks identified in this LHMP

7.2 Future Adaptation Options and Strategies

Numerous reports have compiled lists of sea level rise adaptation options and described their use in addressing different climate risks.[43] Information on the costs to implement these strategies is limited but examples of most strategies exist. Local public works departments are best able to estimate the true costs of various construction projects and municipal planners, NGOs and consultants continue to evaluate the feasibility and efficacy of planning and regulatory options. Table 16 provides an overview of which adaptation strategies may be appropriate for each coastal climate change hazard. A special investigation of the role that natural habitats may play in reducing the vulnerabilities identified within this report was completed by Center for Ocean Solutions[44] (Appendix A). Policy options are also discussed within the report.

7.3 Potential Strategies for Capitola Climate Adaptation

2017-2030 Adaptation Options

Adopt policies to limit municipal capital improvements that would be at risk (Building Codes and Resilient Designs)

Prudent adaptive management to climate change begins with not placing new municipal infrastructure at risk to known future hazards. City policies that establish review processes for proposed Capital Improvement Projects located within future hazard zones have been adopted by the City of San Francisco.[45] These guidelines help staff to review proposed infrastructure projects and ensure that those projects will not become vulnerable to projected climate risks within the projects expected lifespan.

Improve resiliency to flooding along the Creek and Coast (Flood Wall and Elevate)

This risk assessment suggests that flooding of the downtown area will continue to be a primary hazard. Continued focus on emergency response and improved building guidelines (increase free board and first floor parking) can help reduce temporary impacts of flooding. A temporary or permanent flood wall along the Soquel Creek walking path may help to reduce flooding within high risk areas.

Investigate natural habitat buffering to reduce coastal flooding (beach and kelp management)

The Center for Ocean Solutions investigated the protective role that coastal habitats (Kelp, surf grass, wetlands, dunes) may play to reduce projected hazards.[46] Figure 15 shows locations of these habitats. For Capitola, the report finds that "the small beach and lagoon system at the mouth of Soquel Creek plays a relatively moderate role in reducing exposure to erosion and inundation." The report similarly

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[43] Grannis, J. 2011. Adaptation Tool Kit: Sea Level Rise and Coastal Land Use

[44] Center for Ocean Solutions. 2016. Coastal Adaptation Policy Assessment: Monterey Bay

[45] City and County of San Francisco Sea Level Rise Committee. Guidance for Incorporating Sea Level Rise into Capital Planning in San Francisco: Assessing Vulnerability and risk to Support Adaptation. Prepared for the San Francisco Capital Planning Committee. Adopted by Capital Planning Committee December 14, 2015.

[46] Center for Ocean Solutions. 2016. Coastal Adaptation Policy Assessment: Monterey Bay

finds that "the proximity of Capitola's commercial development to the coast limits the city's options for nature-based adaptation strategies." Maintaining Capitola's beach and kelp forests, however, will likely provide some reduction in wave impacts.

Figure 15. Distribution of natural habitats that may play protective role in Capitola.
(Figure source: COS, 2016)

Storm drain upgrades (tidal (flap) gate and pumps)

Storm drains are currently vulnerable to high water during winter storms and these systems may be compromised further as water levels rise at discharge points along the coast and creek. Greater flood water volumes projected in the downtown by 2030 may further strain the effectiveness of the storm drain system. Coastal flood hazard models suggest that 93 storm drain structures may be compromised by high water levels by 2030 (Table 8, page 29). These submerged discharge pipes may become a conduit for inland flooding, possibly bypassing coastal protection structures. To address this issue, storm drain upgrades including gates and check valves should be investigated and additional pumping of storm water within vulnerable storm drains may be needed by 2030. The Capitola Hazard mitigation plan similarly identifies several structures (Noble Gulch Storm Pipe (already repaired), Capitola Pump Station and Soquel Pump Station (both wastewater facilities), and Lawn Way Storm Drain Pump Station) within the FEMA flood zone that may need to be upgraded.

STATE GUIDANCE

The Coastal Act allows for protection of certain existing structures. However, armoring can pose significant impacts to coastal resources.

To minimize impacts, innovative, cutting-edge solutions will be needed, such as the use of living shorelines to protect existing infrastructure, restrictions on redevelopment of properties in hazardous areas, managed retreat, partnerships with land trust organizations to convert at risk areas to open space, or transfer of development rights programs. Strategies tailored to the specific needs of each community should be evaluated for resulting impacts to coastal resources, and should be developed through a public process, in close consultation with the Coastal Commission and in line with the Coastal Act

Coastal Commission support of Cities that update their Local Coastal Plans to include the adaptation measures prioritized by the community can aid successful implementation of a community's adaptation strategy

Living shorelines provide an alternative to bulkheads and seawalls, while also providing critical habitat. (Photo: Tracey Skrabal)

Table 16. List of Adaptation Strategies (short= 0-5 years, med= 5-30 years, long= 30+ years)

TYPE	DURATION OF PROTECTION	RIVER FLOODING	COASTAL STORM FLOODING	EROSION	WAVE IMPACTS	RISING TIDES
Hard						
Levee	medium	•	•			•
Seawall or Revetment	medium		•	•	•	
Tidal Gate	medium		•			•
Flood wall	medium	•	•			•
Groin	medium		•	•	•	
Soft						
Wetland shoreline	medium		•		•	
Dune restoration	medium		•	•	•	•
Beach Nourishment	short		•		•	
Offshore structure	medium		•		•	
Accommodate						
Elevate	medium	•	•			
Managed Retreat						
Retreat	long	•	•	•	•	•
Rolling easement	long	•	•	•	•	•
Strict land use re-zone	long	•	•	•	•	•
Regulatory Tools						
Stricter Zoning	long	•	•	•	•	•
Floodplain Regulations	long	•	•		•	•
Building Codes and Resilient Designs	long	•	•		•	•
Setbacks/Buffers	long	•	•	•	•	•
Rebuilding Restrictions	long	•	•	•	•	•
Planning Tools						
Comprehensive Plan	long	•	•	•	•	•

Rebuild current beach groins

Capitola currently has two groins located on the east end of the main beach. These structures were designed and constructed in response to changes in sediment supply that occurred after the construction of Santa Cruz harbor breakwater. The two groins were constructed in the 1960's to capture sediment being transported east and to build the width of Capitola beach. The groins have since deteriorated, reducing their height and sediment capture efficiency. Rebuilding or upgrading these structures may be a cost-effective adaptation response to mitigate short term beach loss. Long term (2060-2100) capacity of these structures to retain beach width may be reduced as ocean elevations rise.

Using groins to capture sand may lead to accelerated cliff erosion along Grand Avenue. The 2016 TNC report[47] found that the combination of groin construction and beach nourishment was a cost effective medium duration adaptation measure that helped reduce the loss of public beaches and natural habitats for an estimated twenty years (periodic sand replenishment would be required). Although this analysis was done in Monterey County, it provides useful information that may be transferable to Capitola.

Investigate beach nourishment in concert with groins

Small to medium scale opportunistic beach nourishment has been found to be a cost effective, although temporary, adaptation measure when material is available.[48] Such materials are routinely diverted from the Santa Cruz harbor down current towards Capitola (providing beach sands for the Pleasure Point area). Other sources may include excess accumulation in local rivers that compromise flood management. Sediments from dam maintenance projects may also be obtained. Off shore sand has also been examined by the 2016 TNC report and may be cost effective but may also initiate more complex regulatory processes. Groins are recommended to extend sand retention time and upgrades to existing groins should be considered in Capitola to support any beach nourishment project.

Large sand placement projects were estimated to cost approximately $3,300,000 per linear km and opportunistic nourishment was estimated at $400,000 per linear km but must be repeated more often.[49] An example opportunistic sand placement project occurred along Del Monte Beach in Monterey where approximately 8000 cubic meters of sand was placed on the beach between 2012 and 2013. Sand helped protect inland structures but, because no groins were present to limit sand movement, much of the sand was redistributed during 2015 winter storms.[50]

Prioritize coastal protection structures for upgrade and replacement (seawall and revetment)

The most common community response to cliff erosion that threatens private and public property and infrastructure is to construct or upgrade coastal armoring structures. The costs to replace or construct new coastal armoring however, is high. Recent estimates for constructing new seawalls that withstand

[47] Leo et al. 2017. Economic Impacts of Climate Adaptation Strategies for Southern Monterey Bay.

[48] Ibid.

[49] Ibid.

[50] The Watershed Institute, California State University Monterey Bay. A Small-Scale Beach Nourishment Project in Monterey. California. Publication No. WI-2015-05. 25pp.

periodic wave impacts are estimated at up to $52 million per mile.[51] Therefore, completion of a coastal bluff and beach management plan for Capitola that outlines short and long term coastal bluff management strategies will help to establish local protection and adaptation priorities.

The secondary environmental and economic impacts that result from the construction of sea walls are significant. The 2016 TNC report found that coastal armoring was less expensive than beach nourishment and groin construction (although Capitola already has groins in place that may lower costs) and effectively reduced municipal and private property losses. Economic and community impacts from the loss of beach area, however, were estimated to be twice the value of the properties those structures were intended to protect. Therefore, the future allocation of public funds to protect current infrastructure should to be prioritized and weighed against the longevity and feasibility of the proposed protective structures.

Depending on cost, construction feasibility and legality of replacing current protective structures, it may be decided that some of the sea walls may be replaced or upgraded while other development may need to adapt to the projected hazards or be lost. Both the construction costs as well as the secondary implications of such armoring on coastal resources (access, beach width, view) may likely be significant.

Consider resiliency improvements to protect coastal access ways

The City may consider additional resiliency improvements and/or new protective structures to maintain critical vehicular and coastal access ways (including Cliff Drive and the Wharf. note: the City is currently evaluating resiliency improvements for the wharf).

2030-2060 Adaptation Options

Protection of all properties and infrastructure identified at risk during each time horizon is likely infeasible. Therefore, Capitola will need to establish adaptation strategies that best meet local long-term goals. Coastal municipalities will need to set adaptation policies that weigh public cost considerations, longevity of adopted strategies and resultant changes to the community. Establishing equitable managed retreat policies for coastal properties years before they are implemented will benefit successful long-term implementation of these policies and help to ensure the sustainability of the community. Selecting time horizons and climate conditions for which next phase adaptation strategies are triggered will allow the community to anticipate and prepare for future actions.

Identify priority areas for future protection accounting for costs, structural feasibility and secondary implications. (flood wall, seawall or revetment)

This study assumes that the 1.2 miles of coastal protection infrastructure will need to be replaced, upgraded or removed sometime after 2030. Decisions regarding which structures to rebuild in their current location and which structures to remove or relocate (managed retreat) will need to be made.

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[51] ESA-PWA. 2012. Evaluation of Erosion Mitigation Alternatives for Southern Monterey Bay. Report prepared for the Monterey Bay Sanctuary Foundation and the Southern Monterey Bay Coastal Erosion Working Group. http://montereybay.noaa.gov/research/techreports/tresapwa2012.html.

Secondary impacts of coastal protection should be considered including loss of public access, beach area, economic valuation of the beach and impacts to community identity.

Between 2060 and 2100, Capitola is at risk of losing much (95%) of its public beach if all current coastal protection structures are rebuilt in their current location. Additionally, some structures (Venetian Court and Esplanade hip walls) would need to be raised significantly to protect structures from future projected wave impacts. The raising of these walls would likely compromise public and private valuation of the coastline significantly, making such actions undesirable and contrary to Capitola community values.

TNC ECONOMIC ANALYSIS REPORT 2016

The 2016 TNC report suggests that net benefits of non-armoring approaches are consistently greater than armoring approaches for almost all near-term scenarios. Future funding should be sought to further investigate the cost benefit relationships of various adaptation strategies and the legal and financial strategies necessary to offset municipal and private losses with public benefits.

Identify priority areas for managed retreat to retain sufficient beach area for recreational use (Stricter Zoning, Floodplain regulation, Rolling Easements, Retreat)

Further site-specific modeling is needed to identify which areas can be protected from the combined forces of sea level rise and increased storm intensity. Between 2060 and 2100, some properties may be too difficult or expensive to protect in place and therefore a change in use may be necessary. Such policy decisions should be made early enough for property owners to accommodate these changes. Coordination with State and federal agencies can help municipalities implement these policies and ensure that programs are established to compensate private property owners for the transition of private properties to public use (i.e. beaches, public access and river and bluff setbacks).

2060-2100 Adaptation Options

Between 2060 and 2100, increased coastal wave damage, greater flooding frequency and depth, and higher tides may threaten significant portions of current beach front properties. Protection of all properties from these risks may be costly, technically challenging and may degrade *Capitola's unique identity and scenic beauty*. Decisions regarding what the urban/beach front area may look like in 2100 will need to be made much earlier (i.e. coastal bluff and beach management plan) if adaptation is to be strategic and cost effective. Adopting coastal adaptation and retreat policies once all efforts to protect existing infrastructure fail is a more costly strategy.

Implement managed retreat strategies (Comprehensive Plan, Strict land use Re-zone, Rolling Easement)

There are a number of theoretical managed retreat strategies that have been described within the literature. Examples of coastal communities adopting re-zoning, building restrictions and other land use policies to drive the removal of buildings and infrastructure from the California coast, however, are few.

How retreat strategies can be adopted within a fully developed community like Capitola is unclear. Restrictions on redevelopment triggered by coastal development permit actions may lead to individual property owners implementing setbacks and building restrictions while neighbors are not required to comply. Such a case by case (or "Swiss Cheese") approach will most likely have limited success protecting either coastal properties or coastal resources. Rather, adaptation strategies and future land use decisions (that account for the costs to private property owners and the city) should be drafted long before they become enforceable. Programs to systematically implement adopted adaptation strategies along stretches of coastline (similar to Pacifica) will need support of state agencies and non-governmental organizations. The Local Coastal Program could be an excellent tool to drive these strategies.

Cost sharing between private property owners and state and local agencies will need to be defined and local land trusts may play an important role in administering these programs in years to come. Coastal Hazard (similar to Geologic Hazard) Abatement Districts where neighbors collect taxes on their properties to fund neighborhood scale

EXPLORING ADAPTATION POLICY

The Coastal Commission 2015 Guidance references strategies that include:

> *"restrictions on redevelopment of properties in hazardous areas, managed retreat, partnerships with land trust organizations to convert at risk areas to open space, or transfer of development rights programs"*

The 2014 Pacifica LCP[52] sets policy for coastal bluff development so that,

> *"All new development proposed on or adjacent to a coastal bluff shall require a site stability survey conducted by a licensed Certified Engineering Geologist or Geotechnical Engineer to determine the necessary setback, taking into account bluff retreat projected over the economic life of the development."*

This and most revised municipal policies set a process to establish setbacks for new development, there are no policies yet adopted that outline areas where current development will be modified or removed due to changing coastal hazards projected from these climate models.

The Marin SLR Adaptation effort[53] completed focus area analysis of coastal communities (i.e. Bolinas) similar to this Capitola report and has identified infrastructure that will need to be raised or otherwise modified to respond to tides and coastal flooding. Agriculture lands have been identified for transition to wetlands. No residential or commercial private properties have been identified for removal and no procedures have been identified to support municipalities to *"convert at risk areas to open space."*

[52] Dyett and Bhatia. 2014. Draft Pacifica Local Coastal Land Use Plan. Prepared for City of Pacifica. March 2014.

[53] Sea-Level Marin: Adaptation Response Team and Marin County Community Development Agency. 2015. Marin Ocean Coast Sea Level Rise Vulnerability Assessment, Draft Report.

solutions have been suggested to serve this function.

Realign roads and utility infrastructure (Retreat and other building designs)

Future realignment of roadways and utility infrastructure is costly but those costs can be minimized if managed adaptation and retreat policies are established decades before implementation. City and utility districts and companies can integrate future land use changes into current infrastructure repair and replacement decisions to minimize future costs of infrastructure loss and realignment. Basic cost estimate (based on previous reports) to realign roads and infrastructure that may be at risk by 2100 is outlined in Table 14 (page 47).

A draft adaptation strategy for the City of Capitola is provided below (Table 17).

Table 17. Draft Adaptation Strategy for the City of Capitola

ADAPTATION CATEGORY:

1. hard protection 2. soft protection 3. accommodate 4. Managed retreat 5. regulatory 6. planning

COASTAL HAZARDS	THROUGH 2030	CATEGORY	THROUGH 2060	CATEGORY	THROUGH 2100	CATEGORY
Coastal Storm Flooding	employ temporary protective structures	1, 2	employ secondary containment	1, 2	Implement Managed retreat policies	5
	upgrade storm drains	3	upgrade building guidelines in vulnerable areas	6		
	integrate storm pumps into flood response	3	Establish Managed retreat policies	6		
	investigate secondary barriers to coastal flooding	1, 2				
	Maintain and upgrade building standards in vulnerable areas	5				
Wave Impacts	continue winter sand berm placement	2	Establish Managed retreat policies	6	Implement Managed retreat policies	5
	increase efficiency of sand bag deployment	2				
	upgrade building guidelines in vulnerable areas	6				
	maintain coastal protection structures	1				

COASTAL HAZARDS	THROUGH 2030	CATEGORY	THROUGH 2060	CATEGORY	THROUGH 2100	CATEGORY
River Flooding	Increase freeboard along riverwalk (hip wall)	1	Establish Managed retreat policies	6	Implement Managed retreat policies	5
	upgrade storm drains	3				
	integrate storm pumps into adaptation	3				
	upgrade building standards in vulnerable areas	5				
	investigate secondary barriers to river flooding	1, 2				
Erosion	Maintain current coastal protective structures	1	prioritize replacement of coastal protection structures based on cost, feasibility, longevity and secondary implications	1	Implement Managed retreat policies	5
	Upgrade groins on beach	1	Establish Managed retreat policies	6		
	Investigate beach nourishment options	1, 2	Implement Coastal management strategy	5		
	set strategies for unprotected areas identified at risk	6				
	Investigate long-term feasibility and costs of maintaining current placement of coastal structures	6				
Rising Tides	Identify areas vulnerable to tidal flooding and integrate into zoning and building guidelines	6	Establish Managed retreat policies	6	Implement Managed retreat policies	5
	Draft coastal management plan for 2030, 2060 and 2100 to inform land use policy and private investments	6				

8. Conclusion

This vulnerability analysis is intended to provide a projected chronology of future hazards in order to support local adaptation planning and inform discussions within the community and with State regulatory and funding agencies.

Capitola has responded to and adapted to numerous environmental hazards throughout its 150 years. Development has changed, hotels have burned, and the city has flooded. After each disaster, the community has responded through reconstruction, upgraded infrastructure, and modifications in land use, all intended to retain Capitola's unique charm while responding to nature's lessons.

This vulnerability assessment provides projections of future hazards so the community can begin planning for strategic adaptation to these hazards rather than responding to future climatic events without sufficient forethought or understanding of costs and consequences. Capitola is uniquely vulnerable to coastal climate change. Capitola has stepped forward to partner with County and State agencies to complete this vulnerability assessment and begin planning proper responses to these environmental risks. The State has recently begun providing funding for projects that implement adaptation strategies. This vulnerability report is intended to provide Capitola with necessary information to prioritize actions to become more resilient and to partner with state agencies to implement selected priority actions. Additional State and federal funding is needed to aid local municipalities like Capitola who have taken steps to identify appropriate adaptation strategies.

POSSIBLE NEXT STEPS

- Adopt Capital Improvement Project review guidelines for sea level rise hazard areas.
- Integrate 2030 hazard maps into future Capitola Local Hazard Mitigation Plan updates.
- Investigate beach groin upgrade costs and effectiveness.
- Identify and prioritize storm drain upgrades necessary to address future hazards.
- Work with California Coastal Commission to integrate preferred adaptation strategies into the Capitola Local Coastal Program.
- Continue to participate in regional discussions regarding climate hazard avoidance and adaptation best practices.
- Initiate public outreach and education efforts to inform citizens of projected future hazards.

Mechanisms to implement the identified adaptation strategies requires further investigation, coordination among municipalities within the Monterey Bay and coastal California and development of partnerships that ensure efficient implementation of adopted strategies. Additional strategic dialog with California Coastal Commission staff is needed. The climate report team will work with the City of Capitola and Santa Cruz County to obtain additional funding to extend the adaptation opportunity analysis to the rest of Santa Cruz County, expand the environmental and economic implication analysis and further develop an adaptation implementation strategy for integration into general plans and local coastal programs.

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City of Capitola

Coastal Climate Change Vulnerability Report

Appendices

JUNE 2017

CENTRAL COAST WETLANDS GROUP

MOSS LANDING MARINE LABS | 8272 MOSS LANDING RD, MOSS LANDING, CA

Appendix A.

Coastal Adaptation Policy Assessment: Monterey Bay

(Center for Ocean Solution, 2016)

CENTER FOR OCEAN SOLUTIONS

Coastal Adaptation Policy Assessment: Monterey Bay

August 30, 2016

To support decisionmakers in their efforts to manage coastal resources in a changing climate, the Center for Ocean Solutions (Center) engaged with Monterey and Santa Cruz Counties and other partners to model, map and assess the role of natural habitats along the coast of Monterey Bay in providing the ecosystem service of coastal protection. In addition, the Center evaluated existing and potential land use policy strategies that prioritize nature-based climate adaptation strategies. Ecosystem service modeling and assessment was conducted using the Integrated Valuation of Environmental Services and Tradeoffs (InVEST) decision support tool, a suite of tools to map and value the goods and services from nature. Specifically, the Center utilized the InVEST Coastal Vulnerability model for this assessment.

This ecosystem services and adaptation policy assessment focuses on the coastline of Monterey Bay and two specific geographic areas of interest: Capitola in Santa Cruz County and Moss Landing in Monterey County. For each location, we identify the distribution and ecosystem services provided by coastal habitats, map the role of those habitats in reducing exposure to storm impacts, evaluate land use policy adaptation strategies with the potential to maintain or improve nature's role in reducing exposure to these impacts, and highlight policy considerations relevant for each strategy. In addition, we include an introduction to our science-to-policy approach, a compilation of general considerations for pursuing land use policy approaches, as well as a summary of our analysis methodology.

This assessment addresses Task 4B of the Ocean Protection Council's grant entitled: "Collaborative Efforts to Assess SLR Impacts and Evaluate Policy Options for the Monterey Bay Coast." Results from this assessment will inform local planning in both Capitola and Moss Landing, as well as regional or county-wide planning in both Monterey and Santa Cruz Counties. This collaborative, regional project is underway in parallel with other coastal jurisdictions through a statewide investment in updating coastal land use plans in accordance with projections of rising sea levels and more damaging storms.

Coastal Adaptation Policy Assessment: Monterey Bay

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Coastal Adaptation Policy Assessment: Monterey Bay

EXECUTIVE SUMMARY

As sea levels rise, the impacts of more frequent large storm events driven by the El Niño Southern Oscillation (ENSO) will be greater than those historic events of similar magnitude, exposing coastal areas to the combined effects of elevated tides, increased storm run up and enhanced wave impacts. This increase in the frequency and intensity of storms will likely lead to economic, social and environmental vulnerabilities for coastal communities. California has proactively prioritized coastal adaptation planning that addresses vulnerabilities associated with a changing climate. As a result, the Monterey Bay Region is one of many locations to receive significant funding support to conduct a regional assessment of coastal vulnerability. The results of this coastal adaptation policy assessment will provide information that municipalities can leverage as they engage in adaptation planning for coastal land use.

Successful local, regional and state climate adaptation planning should take into account the role of natural habitats in ensuring a resilient coastline. Coastal habitats can play a protective role in reducing exposure to wind and wave impacts while also providing many additional beneficial ecosystem services to people and nature. Through proactive climate adaptation planning, coastal communities should prioritize nature-based strategies (e.g., dune or wetland restoration, conservation easements, etc.) when and where they are most feasible. If nature-based strategies are not practical in a given location, then coastal planners should consider approaches that seek to maintain the integrity of natural habitats and allow for adaptive coastal planning in the future (e.g., planned retreat, redevelopment limits, etc.).

With combined funding from the State Coastal Conservancy's (SCC) Climate Ready and Ocean Protection Council's (OPC) Local Coastal Program Sea Level Rise grant programs, the Monterey Bay Region is a part of a statewide investment to update coastal land use plans in accordance with projections of rising sea levels and more damaging storms. In parallel with additional select counties, the SCC and OPC provided funding in 2013 for Monterey and Santa Cruz Counties to include impacts from rising sea levels in their ongoing Local Coastal Program updates. The full study area includes the Monterey Bay coastline from Año Nuevo in Santa Cruz County to Municipal Wharf Two in Monterey County. Through discussion with county and city planners as well as with grant organizers from Central Coast Wetlands Group, two community-level study areas were identified—Capitola and Moss Landing—for exposure of coastal assets analyses, the role of natural habitats in reducing coastal exposure and the implications for potential climate adaptation strategies. Detailed analysis and synthesis in these case study locations will be the catalyst for similar investigations throughout Monterey Bay and potentially other sections of the California coast.

Executive Summary: Key Messages

Monterey Bay Coastal Study Area

- The Monterey Bay coastline features diverse coastal habitats including: dense kelp forests; brackish wetland habitats along creeks, lagoons, and sloughs; and expansive beach and dune systems that cover the central and southern sections of the coastline.
- While each coastal habitat plays some protective role, the dune systems in southern Monterey Bay play the highest role in reducing exposure of coastal development to erosion and inundation during storms relative to the entire study area.
- Any climate adaptation strategies under consideration along the Monterey Bay coastline should conform with the strictures of the Coastal Act, consider the recommendations from the Coastal Commission's sea level rise guidance, and respect the cultural significance of the region.
- A primary consideration for proactive coastal adaptation is to incentivize proactive climate adaptation planning that utilizes a blend of approaches across multiple timescales; optimal strategies should not limit adaptation options for future generations.

Capitola

- The small beach and lagoon system at the mouth of Soquel Creek plays a relatively moderate role in reducing exposure to erosion and inundation in comparison with the entire study area.
- The proximity of Capitola's commercial development to the coast limits the city's options for nature-based adaptation strategies.
- Adaptation options for developed sections of Capitola include implementing overlay zones that account for anticipated rising seas. In addition, limiting redevelopment or implementing redevelopment guidelines in these zones can provide a plan for relocation in coming years.

Moss Landing

- Relative to the entire Monterey Bay study area, the large dunes north and south of Moss Landing provide the highest protective role from coastal storm impacts.
- Nature-based climate adaptation options in the Moss Landing case study area include restoration or preservation of dune and wetland habitats. In addition, nourishing beachfront locations with additional sediment can be an option if appropriate environmental concerns are addressed.
- Built structures—including some coastal dependent structures—limit adaptation options for parts of Moss Landing. Critical infrastructure such as the Moss Landing power plant, harbor infrastructure, and Highway 1 all present challenges to implementing many otherwise viable strategies.

Our Climate and Ecosystem Services Science-to-Policy Approach

Coastal decisionmakers are actively determining how coastal communities will adapt to rising sea levels and more damaging storms. Favorable adaptation approaches consider the role of natural habitats and prioritize resilient strategies that do not limit future planning options.[1] Since 2010, the Center for Ocean Solutions has worked with coastal planners and managers to incorporate the role of natural habitats in climate adaptation planning.[2] Below, we outline our scalable, transferable approach to bridging a spatial assessment of natural protective services with coastal land use policy decisions in an era of changing climate.[3]

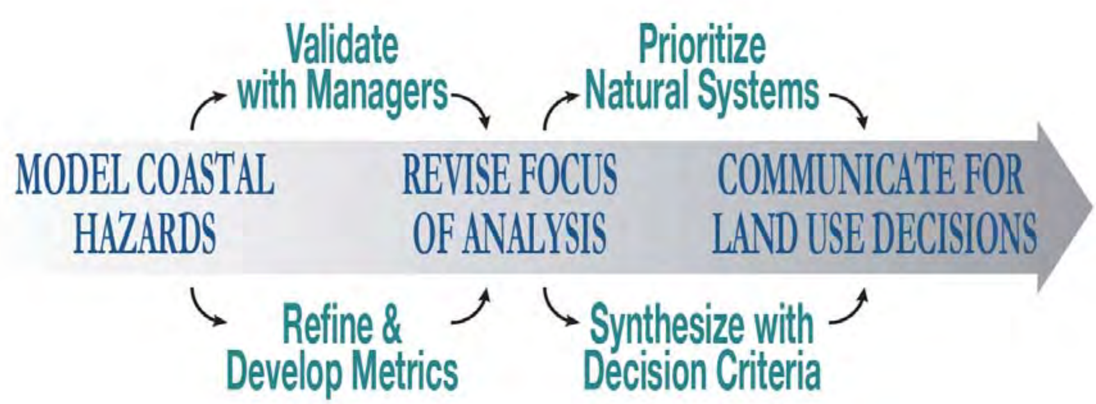

Fig. 1: Our transferable, scalable ecosystem services to coastal adaptation policy approach.

Coastal Ecosystem Services

Ecosystem services are the benefits that natural habitats provide to people (e.g., water purification, aesthetic attachment, carbon sequestration and coastal protection). Thriving, healthy ecosystems provide the greatest provision of services and are most resilient in the face of dynamic environmental conditions. In the coastal context, ecosystems play an important role in protecting shorelines against wave action by dissipating wave energy, or, in the case of sand dunes, physically impeding wave run-up. Climate change impacts, such as rising sea levels and increased storm intensity, are altering patterns of wave action along the coast and exposing new locations to physical forces. As waves travel from the open sea to coastal regions with shallower waters, they interact with the natural and geologic features of the seabed. Increased intensity and frequency of storms and rising seas, further emphasizes the important role of coastal habitats in reducing shoreline erosion and of increasing resilience in coastal areas.

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[1] Jon Barnett & Saffron O'Neill, *Maladaptation* 20 GLOBAL ENVTL. CHANGE 211 (2010).

[2] Suzanne Langridge et al., *Key lessons for incorporating natural infrastructure into regional climate adaptation planning* 95 OCEAN & COASTAL MANAGEMENT 189 (2014); Sarah Reiter et al., *Climate Adaptation Planning in the Monterey Bay Region: An Iterative Spatial Framework for Engagement at the Local Level* 6 NATURAL RESOURCES 375 (2015); Lisa Wedding et al., *Modeling and Mapping Coastal Ecosystem Services to Support Climate Adaptation Planning*, *in* OCEAN SOLUTIONS EARTH SOLUTIONS 389 (Dawn J. Wright ed., 2016).

[3] *See* Figure 1. For further information on this approach, see also the "Analysis, Methodology and Assumptions" section *infra*.

Diverse habitats along California's coastline (e.g., sea grasses, kelp forests, salt marshes, dunes) play a role in reducing exposure to storm impacts while also providing a variety of additional services. As coastal development and rising sea levels degrade or damage these habitats, coastlines, communities and infrastructure become increasingly vulnerable to storms. An important challenge for decisionmakers is determining the best climate adaptation strategies that protect people and property while also protecting the ability of coastal habitats to provide a protective service into the future. To address this challenge, coastal communities need to identify where natural habitats provide the greatest protective benefits so that they may prioritize adaptation planning efforts that protect or restore their critical natural habitats.

Spatial Modeling and Mapping of the Protective Services

Modeling and mapping the ecosystem service of coastal protection can support the spatial prioritization of science-based climate adaptation strategies. For this assessment, we used InVEST (Integrated Valuation of Ecosystem Services and Tradeoffs) in combination with ArcGIS to identify areas where natural coastal habitats provide greater relative protection from storms and shoreline erosion.[4] The spatial models account for service supply (e.g., natural habitats as buffers for storm waves), the location and activities of people who benefit from services and infrastructure potentially affected by coastal storms. The InVEST Coastal Vulnerability model produces a qualitative estimate of coastal impact exposure to erosion and inundation during storms. By coupling exposure results with population information, it can identify the areas along a given coastline where humans are most vulnerable to storm waves and surge. The model does not value any environmental service directly, but ranks sites as having a relatively low, moderate or high risk of erosion and inundation through an exposure index.

The Coastal Exposure index is calculated by combining the ranks of the seven biophysical variables at each shoreline segment: geomorphology, natural habitats (biotic and abiotic), net sea level change, wind and wave exposure, surge potential and relief (bathymetry and topography). Model inputs serve as proxies for various complex shoreline processes that influence exposure to erosion and inundation. The resulting coastal exposure ranks range from very low exposure (rank=1) to very high exposure (rank=5), based on a mixture of user- and model-defined criteria. The model output helps to highlight the relative role of natural habitats at reducing exposure—also through a 1–5 ranking. This relative role output can be used to evaluate, how certain management actions can increase or reduce exposure of human populations to the coastal hazards of erosion and inundation. For this assessment, the model outputs were mapped on the shoreline of the Monterey Bay study area in order to interpret the relative role of natural habitats in reducing nearshore wave energy levels and coastal erosion—thus highlighting the protective services offered by natural habitats to coastal populations.

[4] InVEST is a free and open-source suite of software models created by the Natural Capital Project at the Stanford Woods Institute for the Environment to map and value the goods and services from natural capital. *See* INTEGRATED VALUATION OF ECOSYSTEM SERVICES AND TRADEOFFS, http://www.naturalcapitalproject.org/models/coastal_vulnerability.html (last visited Aug. 30, 2016).

Coastal Vulnerability Model Considerations

While this vulnerability modeling approach includes average wave and storm conditions, the InVEST Coastal Vulnerability model does not account for coastal processes that are unique to a region, nor does it predict changes in fluvial flooding or shoreline position or configuration. The model incorporates a scenario-based approach to evaluate the role that coastal habitats play in reducing exposure to coastal impacts. We use the Coastal Vulnerability index here to better understand the relative contributions of different input variables to coastal exposure and highlight the protective services offered by natural habitats to coastal populations. Results provide a qualitative representation of erosion and inundation risks, rather than quantifying shoreline retreat or inundation limits. The compiled role of habitat map products depicts results from a "presence/absence" analysis that calculates the difference between erosion indices with and without habitats in place. In effect, this approach indicates the change in coastal exposure if natural habitats are lost or degraded.

Connecting Spatial Modeling to Planning

Understanding the role that nearshore habitats play in the protection of coastal communities is increasingly important in the face of a changing climate and rising seas. To develop this analysis, we integrated feedback from coastal planners to better understand their information needs on coastal vulnerability and potential adaptation options. The map products created from the InVEST Coastal Vulnerability model support the spatial evaluation of nature-based adaptation planning alternatives with rising sea levels, and highlight how protective services might change in the future. Connecting these model results with existing land use planning and zoning information and current policies provides a pathway for identifying locations in which nature-based strategies can be prioritized as more effective and feasible than competing traditional strategies.

Monterey Bay Coastal Study Area

Monterey Bay Coastal Management Context

The study area from Año Nuevo in Santa Cruz County to Wharf Two in Monterey County features a diverse range of land uses and densities. This range includes the City of Santa Cruz's highly developed coastline, the sparsely populated coastal properties of southern Santa Cruz County, and undeveloped beaches in Santa Cruz and Monterey Counties.[5] Farmlands dominate much of the inland areas, especially around Watsonville, Castroville, and Salinas. The main feature of the coastline is the Monterey Bay itself, which includes a submarine canyon leading seaward from Elkhorn Slough and the coast of Moss Landing. The Moss Landing power plant is the largest structure on the Bay, and the coastline features numerous important points of interest, roads, critical infrastructure, and research and educational facilities.

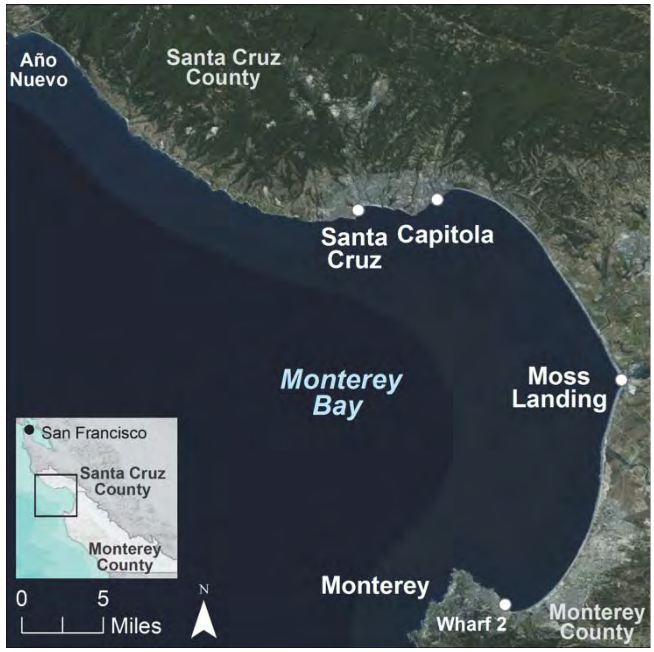

Fig. 2: Satellite image of Monterey Bay.

Several governmental agencies oversee the Monterey Bay coastline. For instance, the California Department of Parks and Recreation manages the state parks and reserves. The California Department of Transportation (CalTrans) oversees the coastal roadways, particularly the Pacific Coast Highway (Highway 1). The California Energy Commission regulates the Moss Landing power plant. The U.S. Fish and Wildlife Service governs the Salinas River National Wildlife Refuge. The National Oceanic and Atmospheric Administration (NOAA) administers the Elkhorn Slough National Estuarine Research Reserve (ESNERR) in partnership with the California Department of Fish and Wildlife. ESNERR and the non-profit Elkhorn Slough Foundation protect 5,500 acres of land, comprising property owned and managed by the reserve and property owned or managed by the foundation in the surrounding hillsides.[6] NOAA also administers the Monterey Bay National Marine Sanctuary and has jurisdiction over the marine mammals in the area. The most active land management agencies in the coastal zone include: the California Coastal Commission, which oversees land use and public access; the State Coastal Conservancy, which strives to protect or improve natural coastal ecosystems; and the State Lands Commission, which manages California's public trust lands.[7]

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[5] The full project study area includes the Monterey Bay coast from Año Nuevo in Santa Cruz County to Municipal Wharf Two in the City of Monterey. Note that this study area does not include sections of Santa Cruz County north of Año Nuevo or sections of Monterey County west and south of Wharf 2. *See* Figure 2.

[6] ELKHORNSLOUGH.ORG, http://www.elkhornslough.org/conservation/what.htm (last visited Aug. 29, 2016).

[7] Public trust lands are held and managed by the state for the benefit of the public. In the coastal zone, public trust lands include all ungranted tide and submerged lands. The Coastal Commission also retains some oversight over the use of granted tide and submerged lands.

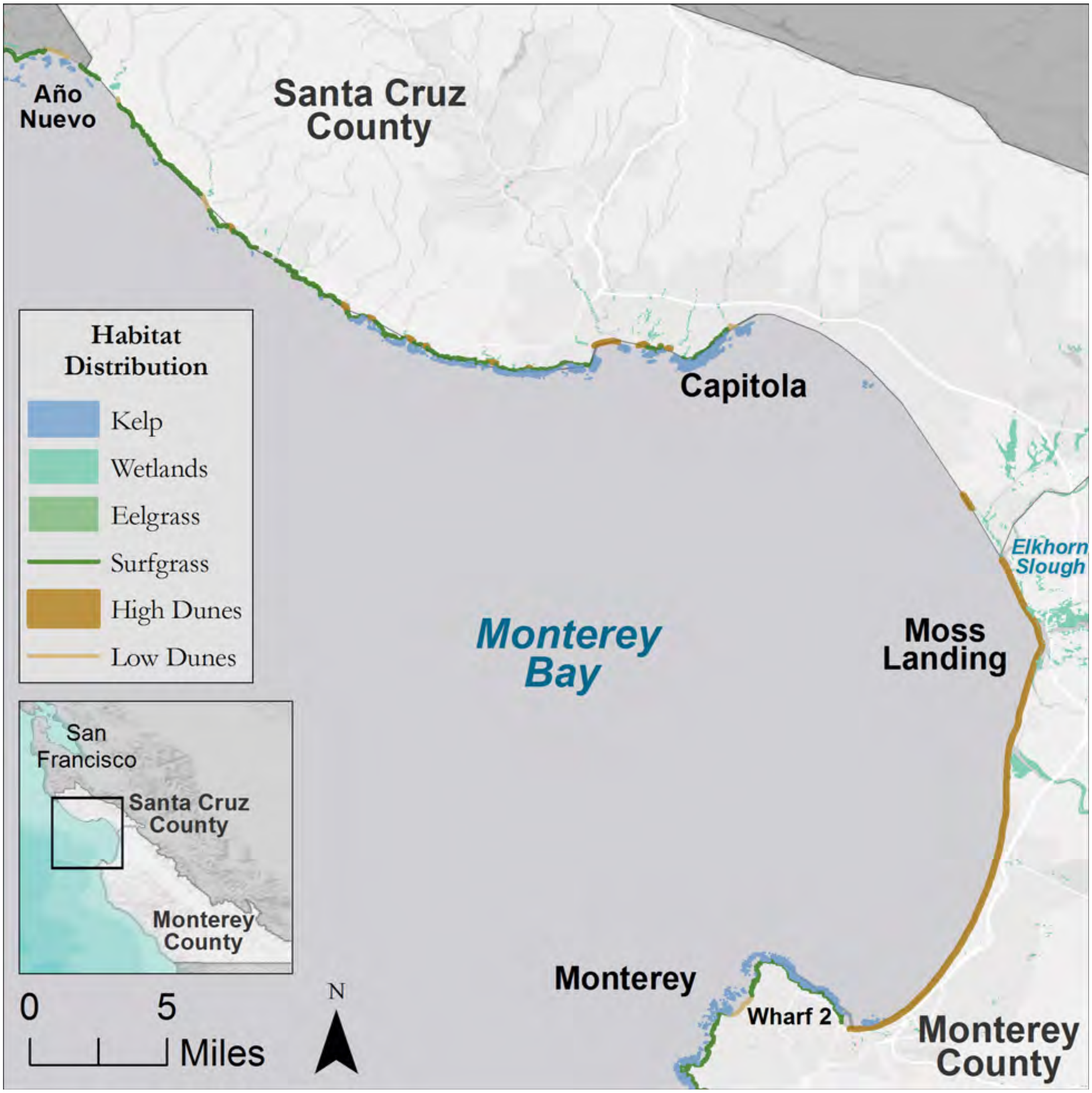

Fig. 3: Coastal habitats in Monterey Bay and surrounding area.

The Pacific coast of Santa Cruz and Monterey Counties has extensive natural habitats including some of the most imperiled habitats in the United States. Freshwater wetlands, coastal prairie and maritime chaparral, as well as kelp forests, estuarine wetlands, small and large beaches, and dunes are all present in the region.[8] The northern section of the study area (Año Nuevo to Capitola) includes a mostly rocky coastline fronted by seaweeds and surfgrass, backed by open agricultural lands. Occasional pocket beaches, typically fed by creeks, interrupt the bluffs and provide coastal access. Near the river mouths of the city of Santa Cruz, there is a greater concentration of small pocket beaches and wetland habitats than elsewhere in the area. The central section of the study

[8] *See* Figure 3.

area (Capitola to Moss Landing), is predominantly characterized by beaches and low dune systems backed by cliffs that decrease in size from north to south. The southern section of the study area (Moss Landing to Monterey) is dominated by large dune systems at the southern extent of the Santa Cruz littoral cell—the cycle of sediment sources and sinks from Pillar Point to the Monterey Canyon.[9] These habitats are all locally important and provides significant ecosystem services and benefits to certain communities.

Monterey Bay Protective Role of Habitats

Coastal habitats provide the ecosystem service of coastal protection for people, property and infrastructure by providing a natural buffer to mitigate erosion and inundation from ocean waves and storms. Our analysis focused on the direct effects of sea level rise on the risk of coastal communities to erosion and flooding. Our model results suggest that with rising sea levels the ability of dune systems to mitigate coastal exposure and keep this section of coastline in the low-moderate exposure range could be compromised.[10] Rising seas will likely impact the protective role of many beaches and dune habitat backed by coastal armoring that could result in the loss of existing beach area and the associated recreation and tourism income to coastal communities.[11] Overall, the loss of coastal dunes, wetlands, kelp forests and seagrass habitats would increase the exposure to erosion and flooding along the Monterey Bay study area. The extensive high dune systems throughout the southern section of Monterey Bay play a relatively high protective role compared to other natural habitats along the coastline. Storm surge is an important model factor from Marina to Monterey which alludes to the high role of coastal habitats in this area for protecting people and property along the coast. The coastal dune habitat in the Monterey Bay region suffers from high rates of erosion.[12] As a result, shoreline armoring has been used extensively along developed areas to address erosion and protect infrastructure and other areas of coastal development from waves, erosion and inundation. With increasing human pressure on these coastal ecosystems, there is a need to prioritize adaptation planning efforts in these important dune systems and other habitats that play significant roles in coastal protection.

Coastal wetlands along Monterey Bay stabilize shorelines and protect coastal communities by attenuating waves. Wetland habitat in the study area provides a relatively moderate role in mitigating erosion and inundation during storms. As sea levels rise, wetlands need to migrate to maintain their protective role. A recent study in Santa Cruz found that 17% of wetland habitat will be unable to migrate with sea level rise due to existing development.[13] The model does not predict migration or loss of habitat under the different sea level rise scenarios. Further research is needed to understand the extent to which habitats will be able to adapt to climate change effects.[14]

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[9] U.S. ARMY CORPS OF ENGINEERS, COASTAL REGIONAL SEDIMENT MANAGEMENT PLAN FOR THE SANTA CRUZ LITTORAL CELL, PILLAR POINT TO MOSS LANDING (2015).

[10] *See* Figure 4.

[11] Philip G. King et al., THE ECONOMIC COSTS OF SEA-LEVEL RISE TO CALIFORNIA BEACH COMMUNITIES (2011).

[12] Gary Griggs & Rogers Johnson, *Coastline erosion: Santa Cruz County, California* 32 CALIFORNIA GEOLOGY 67 (1979); Edward Thornton et al., *Sand mining impacts on long-term dune erosion in southern Monterey Bay* 229 MARINE GEOLOGY 45 (2006).

[13] MATTHEW HEBERGER ET AL., THE IMPACTS OF SEA-LEVEL RISE ON THE CALIFORNIA COAST (2009).

[14] Langridge, *supra* note 2.

The southern coastline of Monterey Bay is exposed to high wave energy, which was a substantial driver of the high coastal exposure in this area. Surfgrass provides some wave attenuation for the adjacent shoreline but compared to other habitats in the study area, it plays a relatively low role in reducing overall exposure. Although kelp forest habitats along the broader Monterey Bay coastline also play a relatively low role in reducing exposure to coastal hazards compared to the coastal dune habitats, these habitats offer important co-benefits to California's people and the economy such as fisheries habitat and recreation.

Monterey Bay Ecosystem Services of Coastal Habitats

The Monterey Bay is nationally regarded as a culturally important marine habitat. This section of the coast includes six state marine protected areas as well as a national marine sanctuary.[15] Monterey Bay also supports a diverse ocean and coastal-based economy including agriculture, tourism, industry, aquaculture, fishing as well as a number of marine research and education institutions. Many tourists flock to the area for offshore whale watching, coastal birding, kayaking, surfing, boating, fishing, and beach-going. The diverse habitats noted below play an important role in preserving the open natural system of this region.

Creeks, Rivers, and Lagoons

Along the Northern coast of Monterey Bay there are numerous creeks and rivers reaching coastal lagoons and beaches along the Pacific shoreline. Several waterways also weave through the urbanized residential areas in Santa Cruz or Capitola, along with more rural neighborhoods such as in Aptos. These coastal waterways provide habitat for commercially important fish species (e.g., salmon and steelhead) during juvenile stages of their lifecycle. Many non-commercial fish and birds are also endemic to these creeks, while amphibians and reptiles use the damp banks for shelter and a source for food.[16] These riparian corridors and their lagoons provide aesthetic value and streamside recreation opportunities in the form of parks and trails, particularly in more urbanized neighborhoods. They also perform water filtration services, and nutrient cycling. When this habitat remains intact, it can aid in flood control and water storage during the wet season and major storm events.[17]

[15] The Marine Protected Areas include: Greyhound Rock and Elkhorn Slough State Marine Conservation Areas as well as Año Nuevo, Natural Bridges, Elkhorn Slough, and Moro Cojo State Marine Reserves.

[16] Mary E. Power et al., *Rivers*, *in* ECOSYSTEMS OF CALIFORNIA 713 (Harold Mooney & Erika Zavaleta eds., 2016).

[17] Walter G. Duffy et al., *Wetlands*, *in* ECOSYSTEMS OF CALIFORNIA 669 (Harold Mooney & Erika Zavaleta eds., 2016).

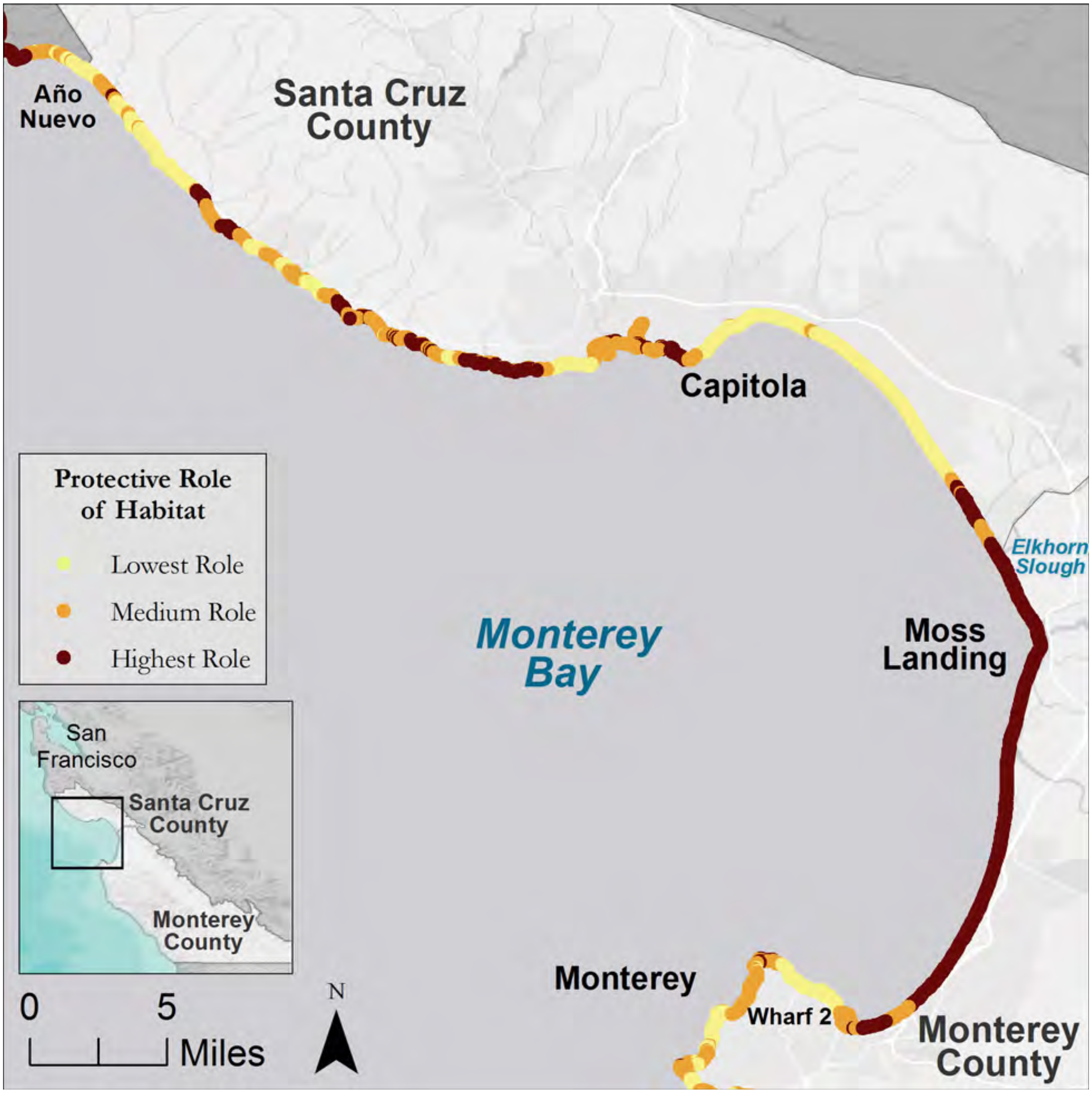

Fig. 4: Relative role of coastal habitats around Monterey Bay in reducing exposure to erosion and inundation.

Kelp Forests of Monterey Bay's Northern Coast

On the Northern end of the bay, near Año Nuevo, dense kelp forests grow from the sandstone and claystone reefs offshore. Kelp forests provide juvenile fish habitat and shelter them from predation. Kelp is also harvested at small scales to provide food for abalone aquaculture, particularly for abalone farms along the wharfs of Monterey.[18] Since no recreational or commercial fishing of any abalone species is allowed south of San Francisco, local aquaculture operations are the only source

[18] Mark H. Carr & Daniel C. Reed, *Shallow Rocky Reefs and Kelp Forests*, *in* ECOSYSTEMS OF CALIFORNIA 311 (Harold Mooney & Erika Zavaleta eds., 2016).

of Monterey Bay abalone for human consumption.[19] Forests of giant kelp (*Macrocystis pyrifera*) and bull kelp *(Nereocystis luetkeana*), nourished by cold, nutrient-rich waters, are highly productive and support a food web of hundreds of fish and invertebrate species along with a diverse assemblage of birds and marine mammals.[20] In addition, litter from broken kelp fronds washes up on local beaches as wrack and detritus, sustaining a separate food web of terrestrial insects and shorebirds.[21] Kelp require high light levels and cool water temperatures to grow. As such they are sensitive to excess sedimentation and nutrient overloads that stimulate growth of light-blocking organisms. Strong wave action from storms can rip out entire kelp patches and significantly damage the remaining fronds. Accordingly, shifts in ocean thermal regimes or winter storm patterns such as El Niño can pose threats to sustaining kelp habitats.[22]

Wetlands of Elkhorn Slough

At the heart of Monterey Bay is Elkhorn Slough, an estuarine system known for its biological significance. Its channels, mudflats, eelgrass beds, salt marshes, and hard substrates provide habitat for more than 100 fish, 265 bird, and 500 marine invertebrate species, and more than two dozen rare, threatened, or endangered species.[23] Elkhorn Slough also provides safe habitat for several species of marine mammals. Sheltered from larger marine predators, harbor seals and Southern sea otters use the Slough as a safe feeding and pupping ground. Because of its rich diversity of birds and mammals, Elkhorn Slough's sheltered waters are a popular location for kayaking, paddle boarding, and wildlife viewing. These wetlands contribute to flood control, water filtration, and nitrogen runoff control services.[24] Wetlands provide additional benefits as sinks for carbon through their vegetation growth and accumulation of slowly decomposing sediment.[25]

Coastal Dune and Beach Systems

Extensive coastal dune systems along the southern coast of Monterey Bay support important plant communities between mean high tide and the furthest reach of storm waves.[26] The Monterey Bay beaches and dunes are also a favorite for locals and tourists alike due to its pristine coastline and sandy shores along many coastal access sites. The beach and dune habitats in this region also

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[19] CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE, STATUS OF THE FISHERIES REPORT (2011).

[20] Yuri Springer et al., *Toward ecosystem-based management of marine macroalgae—the bull kelp, Nereocystis luetkeana* 48 OCEANOGR. MAR. BIOL. ANNUAL REVIEW 1 (2010); *see also* Carr & Reed, *supra* note 18.

[21] Jenny Dugan et al., *The response of macrofauna communities and shorebirds to macrophyte wrack subsidies on exposed sandy beaches of southern California* 58 ESTUARINE COASTAL AND SHELF SCIENCE 25 (2003).

[22] Yuri Springer et al., *Toward ecosystem-based management of marine macroalgae - the bull kelp, Nereocystis luetkeana* 48 OCEANOGRAPHY AND MARINE BIOLOGY: AN ANNUAL REVIEW 1 (2010); Paul Dayton & Mia Tegner, *Catastrophic Storms, El Niño, and Patch Stability in a Southern California Kelp Community* 224 SCIENCE 283 (1984).

[23] CHANGES IN A CALIFORNIA ESTUARY: A PROFILE OF ELKHORN SLOUGH 4 (Jane Caffrey et al. eds., 2002) (Elkhorn Slough's habitats include "the slough's channels, mudflats, eelgrass beds, salt marsh, and hard substrate; the adjacent harbor, coastal dunes, and open beaches; and the grasslands, oak, woodlands, chaparral, and other upland areas.").; Jessica Lyons, *Scientists and Activists Aim to Save Elkhorn Slough from Erosion and Development Before it is too Late*, MONTEREY CNTY. WEEKLY, Dec. 13, 2007, *available at* http://www.montereycountyweekly.com/news/cover/article_11c69d2e-dfd5-502d-92ca-bada34be8709.html.

[24] James E. Cloern et al., *Estuaries: Life on the Edge*, *in* ECOSYSTEMS OF CALIFORNIA 359 (Harold Mooney & Erika Zavaleta eds., 2016).

[25] John Callaway et al., *Carbon Sequestration and Sediment Accretion in San Francisco Bay Tidal Wetlands* 35 ESTUARIES AND COASTS 1163 (2012).

[26] Iris Hendriks et al., *Photosynthetic activity buffers ocean acidification in seagrass meadows* 11 BIOGEOSCIENCES 333 (2014).

provide numerous benefits to people and nature, such as critical shoreline bird habitat, mammal haul out locations, as well as coastal recreation and shoreline fishing spots.

General Policy Considerations

There are several general policy considerations that apply to the entire study area, regardless of the adaptation strategy implemented.[27] Most importantly, any climate adaptation strategies should conform to the various strictures of the Coastal Act, and take into account the Coastal Commission's sea level rise recommendations. Additionally, adaptation solutions should be place-based, designed with each specific location's characteristics and limitations in mind. Adaptation strategies should also incentivize proactive planning and limit subsidizing building in hazardous locations. Finally, the cultural significance of the study area should be considered. These considerations are investigated below.

The Coastal Act sets out various legal requirements with which all coastal adaptation policies must be consistent.[28] Likewise, the Commission's Sea Level Rise Guidance (Guidance) contains several persuasive and compelling recommendations. The Guidance recommends pursuing a suite of actions designed to protect in the short term, accommodate in the midterm, and promote retreat in the long term, instead of focusing on any one strategy type or time scales.[29] This hybrid approach permits flexibility and allows communities to tailor adaptation strategies to their unique circumstances. For instance, it would allow the use of protection, accommodation, and retreat strategies simultaneously—as needed and as appropriate—and would also allow these strategies to change over time.[30] Under such an approach, protection of existing structures is allowed but may be limited by certain factors, such as the economic life of a structure.

While a variety of coastal adaptation strategies for adjusting coastal land uses in response to climate impacts are possible in any given area, the appropriate adaptation measures for specific locations will depend on factors such as those locations' topographies and existing infrastructure. Accordingly, each location's unique characteristics should inform the adaptation strategies employed there. For example, the strategies suitable for the study area's open and undeveloped coastlines are likely unsuitable for the city of Santa Cruz and other highly developed areas. Furthermore, specific strategies should take into account predicted rates of local sea level rise and an area's vulnerability to storm events. Finally, existing regulations for each targeted location—such as local coastal programs, rules specific to the Monterey Bay National Marine Sanctuary[31] and any other applicable federal, state or local laws[32]—should be noted and followed.

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[27] These considerations are in addition to the overarching policy consideration of this assessment: that nature-based solutions could be prioritized when possible to ensure maximum co-benefits and beneficial services associated with these strategies.

[28] *See, e.g.*, CAL. PUB. RES. CODE §30235.

[29] CALIFORNIA COASTAL COMMISSION, SEA LEVEL RISE ADOPTED POLICY GUIDANCE 125 (2015) *available at* http://www.coastal.ca.gov/climate/slrguidance.html.

[30] *Id.* at 122-23 ("In many cases, a hybrid approach that uses strategies from multiple categories will be necessary, and the suite of strategies chosen may need to change over time.").

[31] *See, e.g.*, 15 C.F.R. § 922.132 (listing prohibited or otherwise regulated activities in the MBNMS).

[32] For instance, the National Historic Preservation Act of 1966 would govern efforts to move or alter historic buildings on the National Register of Historic Places. 16 U.S.C. §§ 470 *et seq.*

Keeping these limitations in mind, communities should pursue strategies that internalize the risks associated with building and buying properties in hazardous locations and incentivize proactive planned retreat and relocation where appropriate. Proactive planning is especially important in areas with a large number of repetitive loss properties, such as Aptos.[33] Superstorm Sandy and other disasters have proven that making decisions early is less expensive, and potentially less devastating, than waiting until the effects of a disaster take hold.[34] One way governments could internalize the risks associated with building in hazardous locations would be to stop spending public funds to rebuild private structures on sites damaged by rising seas and storms. Another option to internalize these risks would be to amend existing flood insurance policies.[35]

The cultural significance of California's beaches and the Monterey area can also be considered. California's beaches are important to Californians and play a large part in the State's identity. Furthermore, Monterey, and its surrounding areas, are culturally important for many reasons. Coastal adaptation planning can take the area's rich heritage into account when considering which coastal adaptation strategies to pursue. Particularly, adaptation decisions should consider the potential social impacts of decisions affecting culturally and socially significant areas. Moreover, culturally important points of interest in the area should be preserved if possible. Accordingly, decisionmakers can consider the social impacts of any proposed adaptation actions when prioritizing coastal adaptation strategies.

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[33] Particularly State Park Drive and Beach Drive in Aptos, CA. COUNTY OF SANTA CRUZ LOCAL HAZARD MITIGATION PLAN 2015-2020 64 (2015) *available at* http://www.sccoplanning.com/Portals/2/County/Planning/policy/2015%20LHMP%20Public%20Review%20Draft.pdf.

[34] *See, e.g.*, Anne R. Siders, *Anatomy of a Buyout—New York Post-Superstorm Sandy*, Vermont Law School 16th Annual Conference on Litigating Takings Challenges to Land Use and Environmental Regulations (Nov. 22, 2013) (explaining lessons learned in acquisition and buyout programs post-Sandy in New York).

[35] Such a change would need to come at the federal level through amendment to the National Flood Insurance Program. 42 U.S.C. § 4001.

Community-Level Study Areas

Capitola: Coastal Setting

Fig. 5: Satellite image of Capitola.

Capitola was one of the earliest populated beaches on the west coast and hosts a highly developed coastline. Similar to the neighboring city of Santa Cruz, Capitola faces flooding, cliff erosion and episodic bluff failure during King Tides—highest annual tides—and ENSO storm events. Soquel Creek bisects Capitola, and its beach, and plays a large role in riverine inundation in the area. Riprap lines the beach and protects both the beach and development beyond it, such as a modest commercial area that is the economic center of the community.

Capitola's unique characteristics inform the adaptation policies and strategies that might be prioritized in the area.[36] The coastal city of Capitola is dominated by steep cliffs, pocket beaches and low dune systems. Surfgrass beds line the shore and kelp forests populate nearshore reefs from the mouth of Soquel Creek westward toward the city of Santa Cruz. There are a number of low coastal terraces and cliffs that allow coastal access to these scattered beaches. Downtown Capitola and Capitola Beach are saddled between two steep coastal cliffs forming an economically important beachfront tourist destination and coastal recreation site for the community. Soquel Creek runs through downtown Capitola, housing a string of wetlands before flowing to the ocean through an ephemeral lagoon system.

Capitola: Protective Role of Habitats

The low dune and beach habitat in Capitola plays a relatively moderate role in reducing the exposure of Capitola Village and the mouth of Soquel Creek to erosion and inundation during storms compared to the lower protection provided by rest of the adjacent coastline.[37] Beach sands in front of the creek mouth buffer wave run-up and the reach of salt water upstream during storm surge. The main drivers of coastal exposure in the Capitola area are the low elevation and erodible geomorphology surrounding Soquel Creek. The presence of wetlands reduces wave heights along the overall Monterey Bay coastline as coastal wetland and creek vegetation serve as a shoreline buffer. However, model results suggest that Soquel Creek does not serve a strong role in protecting the Capitola shoreline in all locations or scenarios due to the low-lying elevation and coastal flooding during storm events. This phenomenon is not unique to Soquel Creek as large scale regional erosion and river outflow can often overwhelm the ability of vegetation to attenuate waves.[38] The Capitola area is less exposed to wind and waves compared to the broader Monterey Bay study region, yet the relatively greater distance from the continental shelf drives an increase in storm surge potential. Kelp forest habitats along the broader Capitola coastline play a relatively low protective role, based on the model ranking methodology, in reducing exposure compared to the coastal dune and wetland habitats in this area.

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[36] *See* Figure 5.
[37] *See* Figure 6.
[38] Keryn Gedan et al., *The present and future role of coastal wetland vegetation in protecting shorelines: answering recent challenges to the paradigm* 106 CLIMATIC CHANGE 7 (2011).

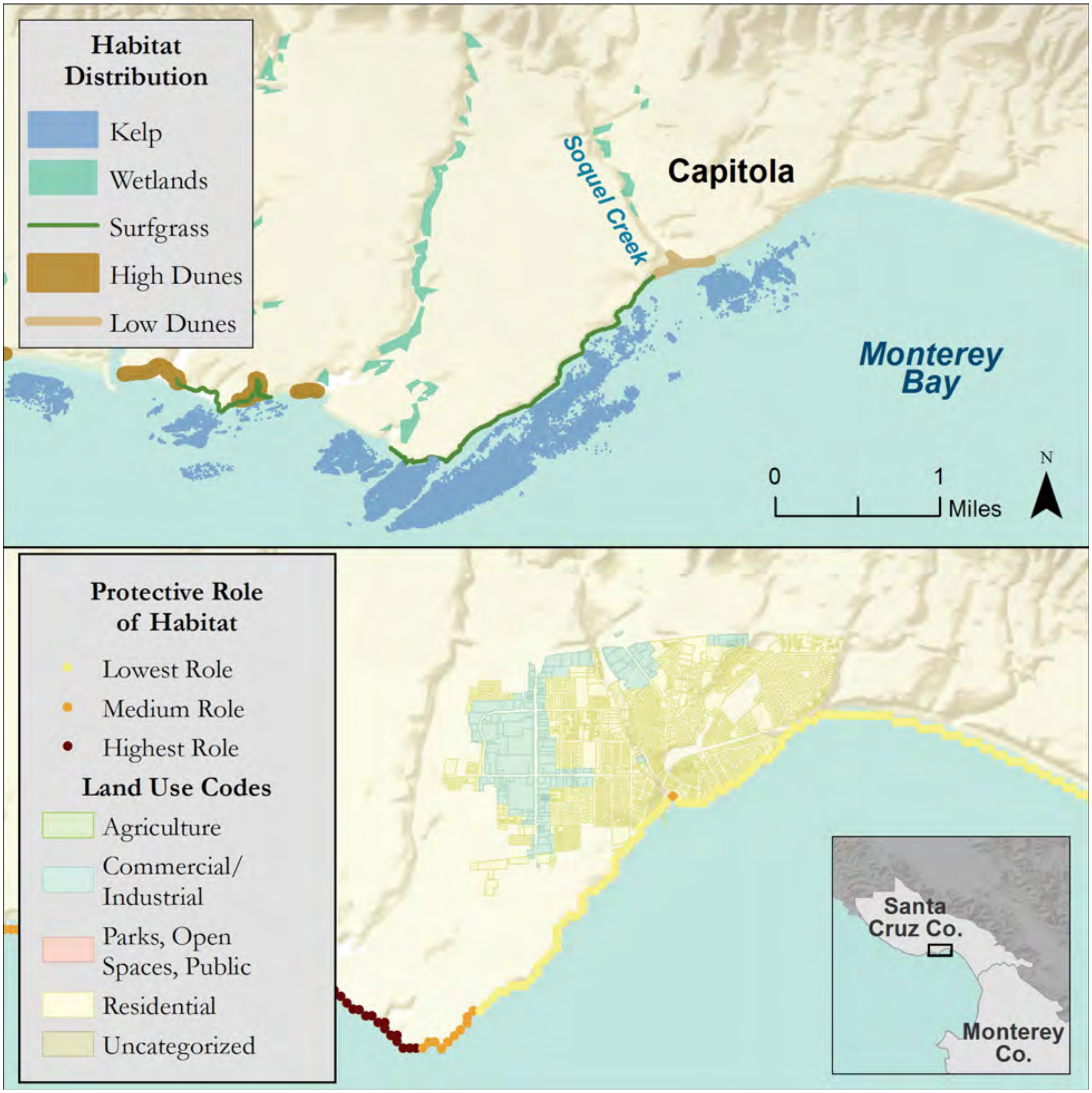

Fig. 6: Coastal habitats around Capitola, CA (Top). The relative role of coastal habitats along the shoreline of Capitola in reducing exposure to erosion and inundation with relevant land use zoning information (Bottom). Land use categories from the General Plan Land Use Codes were aggregated into four broad land use codes (see Bottom legend). Nearly all areas belonged distinctly to one category of land use. Only one land classification, Visitor Serving/L-M Density Residential, had uses from multiple categories, and it was categorized as Residential for this map.

Capitola: Ecosystem Services of Coastal Habitats

Wetlands in Riverine System

As Soquel Creek approaches the Pacific Ocean, the change in slope provides opportune locations for wetland habitats that slow the pace of the river and filter nutrients and pollutants, which leads to an improvement in water quality.[39] Closer to the coast, the river may transition into a lagoon

[39] Duffy et al., *supra* note 17.

system depending on the extent of the beach and low dune system at the mouth. Fish, small invertebrates and birds inhabit the lagoon as a feeding and breeding ground.[40] During strong rains, the lagoon typically breaches to create a direct opening to the ocean.[41] The distinction between this tidal versus lagoon interface plays a significant role in managing flood risks for the city of Capitola, particularly due to the many homes that line the creek and lagoon. While lagoon status influences the volume of tidal water that enters the creek system, intact wetlands can buffer surrounding areas against inundation. For instance, water is absorbed into soils instead of collecting on impermeable surfaces.[42]

Coastal Dune and Beach Systems

The beach and low dune habitat along the mouth of Soquel Creek provides the coastal community with recreation opportunities (e.g., surfing, fishing, kayaking, swimming, beach access). The Capitola Village and beach areas near the mouth of the creek draw over twenty percent of Santa Cruz County's tourism visitors annually.[43] The lagoon system at the mouth of Soquel Creek is actively managed by articifical breaching to release water as part of flood control and water quality maintainence. When open to the ocean, lagoons effectively function as small estuaries. Breaching alters the amount of tidal exchange, temperatures, salinity profiles and water flow for the lower portion of the creek. Depending on time of year and conditions surrounding the breaching event, the shift from closed to open system may influence patterns of species movement and habitat use.[44] Controlled breaching events are typically closely overseen by City Watershed Management monitoring teams, with crews on hand to keep threatened and endangered fish in their respective habitats with nets or transport upstream if needed.[45]

Kelp Forests and Surfgrass

Surfgrass and kelp forest habitats near the Capitola shoreline serve an important natural service by providing food and habitat for a suite of marine species that are also important to recreational fishing for residents and visitors. Kelp forests of the Monterey Bay support rockfish, urchins, crabs and many other commercially valuable species, while surfgrass acts as a nursery for juveniles of these adult kelp forest species.[46] Detritus from kelp forests washes out into open water and submarine canyons, providing subsidies of nutrients and food material to the Monterey Bay's deeper habitats.[47]

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[40] Cloern et al., *supra* note 24.
[41] *Id.*
[42] Walter Duffy and Sharon Kahara, *Wetland ecosystem services in California's Central Valley and implications for the Wetland Reserve Program* 21 ECOLOGICAL APPLICATIONS S18 (2011).
[43] LAUREN SCHLAU CONSULTING, SANTA CRUZ COUNTY VISITOR PROFILE (2010).
[44] Cloern et al., *supra* note 24.
[45] Jessica York, *Beach lagoon breached to alleviate flooding*, SANTA CRUZ SENTINEL, August 17, 2015, http://www.santacruzsentinel.com/article/NE/20150817/NEWS/150819676.
[46] Kevin Hovel, *Habitat fragmentation in marine landscapes: relative effects of habitat cover and configuration on juvenile crab survival in California and North Carolina seagrass beds* 110 BIOLOGICAL CONSERVATION 401 (2003); Carey J. Galst & Todd W. Anderson, *Fish-habitat associations and the role of disturbance in surfgrass beds* 365 MARINE ECOLOGY PROGRESS SERIES 177 (2008); *see also* Carr & Reed, *supra* note 18.
[47] Christopher Harrold et al., *Organic enrichment of submarine-canyon and continental-shelf macroalgal drift imported from nearshore kelp forests benthic communities by macroalgal drift imported from nearshore kelp forests* 43 LIMNOLOGY & OCEANOGRAPHY 669 (1998).

Both kelp forests and surfgrass beds also have potential to sequester some carbon dioxide from the atmosphere and surrounding water by incorporating carbon into their tissues. On a short-term scale, photosynthesis temporarily removes carbon dioxide from the water during the day, potentially reducing the impacts of ocean acidification.[48] Over time, marine sediments slowly bury and trap the plant matter—and therefore the carbon—for longer time scales.[49] As carbon sequestration markets develop, this ecosystem function could be of economic interest to the Capitola area from both a hazard and emission mitigation perspective.

Capitola: Adaptation Strategies & Considerations

Coastal Adaptation Options

Capitola's highly developed coastline limits the available coastal adaptation options. Due to high-density development and the prevalence of cliffs and bluffs, limited opportunities exist to apply nature-based strategies, with the exception of Capitola's beach—a possible candidate for beach nourishment. Beach nourishment could reinforce the beach and surrounding areas, slowing coastal erosion due to rising seas. This strategy would also buffer the upland structures—at least in the short term—from rising seas and storm events.

Other adaptation options would also be feasible in Capitola. A particularly useful and flexible option would be to develop sea level rise overlay zones for Capitola's vulnerable areas.[50] An overlay zone is a tool that groups certain properties together because of a feature they share, or because of some regulatory aim that a local government wishes to accomplish. An overlay zone would allow additional zoning regulations or building code restrictions to be established in the future for the properties in that zone, as deemed necessary. Establishing a sea level rise overlay zone would provide immediate notice to owners of homes and businesses that they are in an area that is vulnerable to rising sea levels.[51] This zone could be coterminous with, or go beyond, existing floodplain zones in the area.[52]

Overlay zones can also designate certain areas as protection, accommodation, or retreat zones and implement appropriate regulations for restricting future development and redevelopment in each zone. For instance, regulations might allow rebuilding of structures in an "accommodation zone," but only if they are raised or otherwise built to withstand rising seas. Likewise, a "retreat zone" might include setbacks and other redevelopment restrictions, such as requiring certain uses to end after a specific time period. Finally, a "protection zone" could allow protection strategies for properties that feature coastal dependent structures, such as harbors.

An overlay zone might also include additional strategies to promote responsible coastal adaptation. For instance, redevelopment in vulnerable areas could be limited through downzoning. This

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[48] Hendriks, *supra* note 26; Lester Kwiatkowski et al., *Nighttime Dissolution in a Temperate Coastal Ocean Ecosystem Increases under Acidification* 6 SCIENTIFIC REPORTS 1 (2016).

[49] Elizabeth McLeod et al., *A blueprint for blue carbon: Toward an improved understanding of the role of vegetated coastal habitats in sequestering CO_2* 9 FRONTIERS IN ECOLOGY AND THE ENVIRONMENT 552.

[50] Capitola currently uses several overlay districts in its zoning classifications. *See, e.g.,* CAPITOLA CITY, CAL., MUNICIPAL CODE §17.20.010 (affordable housing overlay district).

[51] A building moratorium could be put in place while overlay zones are developed. The building moratorium could encompass all areas that might be included in these zones. *See* CAL. GOV. CODE § 65858 (outlining procedures for local governments adopting interim ordinances as urgency measures).

[52] CAPITOLA CITY, CAL., MUNICIPAL CODE §17.50.090.

strategy rezones land to less intensive uses. Currently, the properties at the greatest risk of flooding and rising seas in Capitola are those close to Soquel Creek. These properties are currently zoned for several different land uses and could be prioritized for efforts to downzone.[53] Downzoning would lead to nonconforming uses in the short term—i.e., uses not allowed under the new zoning ordinances, but nonetheless "grandfathered" in because they existed prior to the downzoning. Regulations can be framed to allow these nonconforming uses initially but require them to cease after some period of time.

To achieve these longer-term coastal adaptation strategies, Capitola could consider taking several proactive steps in the short term. For instance, retreat strategies require that uplands be identified and purchased to make space for relocated structures. Land banking properties now could satisfy this future need.[54] Since these lands might not be used for this purpose immediately, this strategy could proceed gradually through phased and voluntary purchases of suitable upland properties. If this strategy does not succeed, or if the timeline becomes more urgent due to rising seas, it could be accomplished through eminent domain.[55] Likewise, Capitola could use transfers of development rights (TDRs) (where landowners sell the rights to develop their property) of vulnerable properties to help facilitate retreat.[56] This strategy could monetarily incentivize coastal landowners to provide their properties for retreat, and it could keep undeveloped coastal land undeveloped.

Capitola's existing coastal protection structures might also be studied to determine their efficacy and need for replacement or removal. Capitola's large sandy beach currently relies on two rip-rap groins on its east end to accumulate sand. To facilitate managed retreat, some of the existing coastal protection structures might need to be phased out. Others might need to be replaced if they are deemed necessary to coastal protection and provided they fit within Capitola's overall coastal adaptation strategy now and in the projected future.

Barriers and Considerations

There are several considerations that should be taken into account when moving forward with any of these coastal adaptation strategies in Capitola. First, limited undeveloped land is available immediately upland of the vulnerable areas, limiting retreat options in the area. As a result, businesses and residences that relocate might have to be moved farther inland than would be necessary elsewhere on the coast. Furthermore, the vulnerability of properties on bluffs and cliffs are less predictable than those along the lower-lying coastline, making long-term planning in these areas more challenging.[57]

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[53] *See* Figure 6.

[54] Land banking is the buying of land for some future use. Michael Allan Wolf, *Strategies for Making Sea-Level Rise Adaptation Tools "Takings-Proof"* 28 J. LAND USE & ENVTL. L. 157, 182 (2013).

[55] Eminent domain is the power of the government to take land for a public purpose. This power is limited by the U.S. Constitution and the California Constitution. U.S. CONST. AMEND. V; CAL. CONST. ART. I § 19.

[56] JESSICA GRANNIS, ADAPTATION TOOL KIT: SEA-LEVEL RISE AND COASTAL LAND USE 57-60 (2011).

[57] Cliffs and bluffs are more vulnerable to episodic erosion than beaches, which alternatively face constant erosive pressures. *See, e.g.,* episodic erosion events at Pacifica Lands End Apartments.

Takings concerns routinely arise when local governments undertake proactive planning for rising seas.[58] To avoid takings concerns, restrictions could be tailored to avoid depriving property owners of all economic value of their parcels.[59] Furthermore, restrictions could account for the economic lives of properties to avoid takings concerns, or could be grounded in avoiding and abating nuisances. Furthermore, any building moratoria could be tailored to be temporary.[60]

Third, regarding zoning classifications, any changes to the current classifications would likely include a grandfather provision allowing existing nonconforming uses to continue.[61] If grandfathering provisions are included in new ordinances, downzoning would only immediately affect undeveloped properties or properties whose uses have been abandoned. But, "grandfathered" provisions could be written to require landowners to comply with new zoning restrictions after a landowner renovates or rebuilds on his property, or when s/he changes the use.[62] Furthermore, as explained above, nonconforming uses could only be allowed for a certain period of time, after which they must cease.

Finally, cost and ecological drawbacks of proposed coastal adaptation strategies are necessary considerations when planning coastal adaptation strategies in Capitola. Cost is an important consideration because Capitola is highly developed and much of its vulnerable areas are in private ownership. Some parcels will be more expensive to buyout or pay just compensation for than others. Likewise, buyouts of private property might be less feasible than comparable options involving state or city lands. Property buyouts to facilitate relocation and to promote retreat face similar concerns. Likewise, cost versus long-term benefits of competing coastal adaptation options should be considered. Similarly, the ecological drawbacks of strategies such as beach nourishment should be weighed against their cost and their relatively short-term effectiveness.

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[58] Governmental taking of private property for public good—as well as regulations that "go too far" and result in "regulatory takings"—are common themes and constant considerations that arise when considering coastal adaptation strategies that require retreat from increasingly dangerous coastlines due to rising seas. Penn Coal Co. v. Mahon, 260 U.S. 393 (1922).

[59] Lucas v. South Carolina Coastal Council, 505 U.S. 1003 (1992).

[60] Tahoe-Sierra Preservation Council, Inc. v. Tahoe Regional Planning Agency, 535 U.S. 302 (2002).

[61] *See, e.g.,* CAPITOLA MUNICIPAL CODE § 17.50.310 ("A structure which was lawful before enactment of this chapter, but which is not in conformity with the provisions of this chapter, may be continued as a nonconforming structure subject to the following condition: if any nonconforming structure is destroyed by flood, earthquake, tsunami or, for another cause to the extent of fifty percent or more of its fair market value immediately prior to the destruction, it shall not be reconstructed except in conformity with the provisions of this chapter.").

[62] Local governments may end nonconforming uses in a variety of ways. Declare nuisance, pay just compensation, or require use to stop after a date certain. CECILY TALBERT BARCLAY & MATTHEW S. GRAY, CALIFORNIA LAND USE & PLANNING LAW 60-61 (2016).

Moss Landing: Coastal Setting

Moss Landing's relatively undeveloped coastline, surrounded by large tracts of farmlands, provides more adaptation options than other more densely populated sections of the coast. The shores surrounding Moss Landing are lined with high dune and sandy beach habitats extending north to Rio Del Mar and south to the edges of the city of Monterey.[63] This area includes many state beaches as well as local beach access points. Sediment for these beaches originates from rivers draining into the Monterey Bay.[64] Just inland of Highway 1, Elkhorn Slough drains the seasonal creeks and rivers that supply water to the surrounding agricultural areas, creating a network of wetlands and estuaries of gradually changing salinity.[65] Within the estuary, eelgrass and salt marsh habitats are prevalent. Much of this area is part of the ESNERR or the California network of Marine Protected Areas. While agriculture often runs up to the boundaries of arable land, most public recreational access to the water is constrained to a few entry points in local parks or at the Moss Landing Harbor.

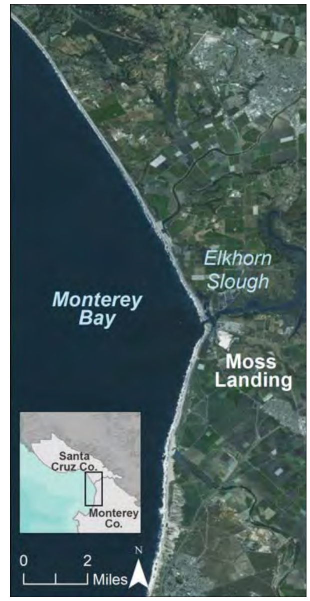

Fig. 7: Satellite image of Moss Landing.

Moss Landing is the center point of the Monterey Bay coastline and is adjacent to diverse natural systems, including extensive wetland habitats in nearby Elkhorn Slough, sand dunes along the open coast, and sandy beaches north and south of the harbor mouth. Along with this connection to multiple natural systems, Moss Landing is a primary commercial and party-boat fishing hub for the central California coast with landing locations for market squid, rockfish, crab, lingcod, groundfish and other fisheries. Moss Landing also functions as a key marine research center due to the confluence of ecosystems and direct access to the deep Monterey Submarine Canyon.[66]

Moss Landing: Protective Role of Habitats

The dune and beach systems starting just north of Moss Landing and continuing south to Monterey play a greater protective role relative to the full study area extent.[67] The orientation of the coastline in the Moss Landing study area, which directly faces predominant incoming waves, is a significant driver of exposure in this region. In addition, coastal geomorphology and low elevation contribute to high exposure index scores in this location, meaning that existing habitats are critical to countering this relatively high exposure to hazards. Model results indicate that the presence of wetlands can reduce wave heights and associated damages to property from storm events. Coastal wetlands are not as effective at reducing erosion in areas of high wave energy.[68] The Moss Landing coastline is a high wave energy environment and the wetlands in this area play a moderate role in reducing coastal exposure to erosion and inundation during storms compared to the large dune

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[63] *See* Figure 7.
[64] *See* U.S. ARMY CORPS OF ENGINEERS, *supra* note 9.
[65] A key concern in this area is the historic changes in groundwater levels in the Pajaro and Salinas Valleys. These changes are further exacerbated by the effect of saltwater intrusion on highly productive agricultural lands as well as domestic potable water quality.
[66] Monterey Bay Aquarium Research Institute (MBARI) and Moss Landing Marine Labs (MLML) are two primary centers for marine research in the region.
[67] *See* Figure 7.
[68] Gedan, *supra* note 38.

systems. Loss of wetland habitat with rising seas will affect agriculture lands near Moss Landing. These wetland areas are highly exposed to waves mainly due to their large extent and proximity to the coastal zone.

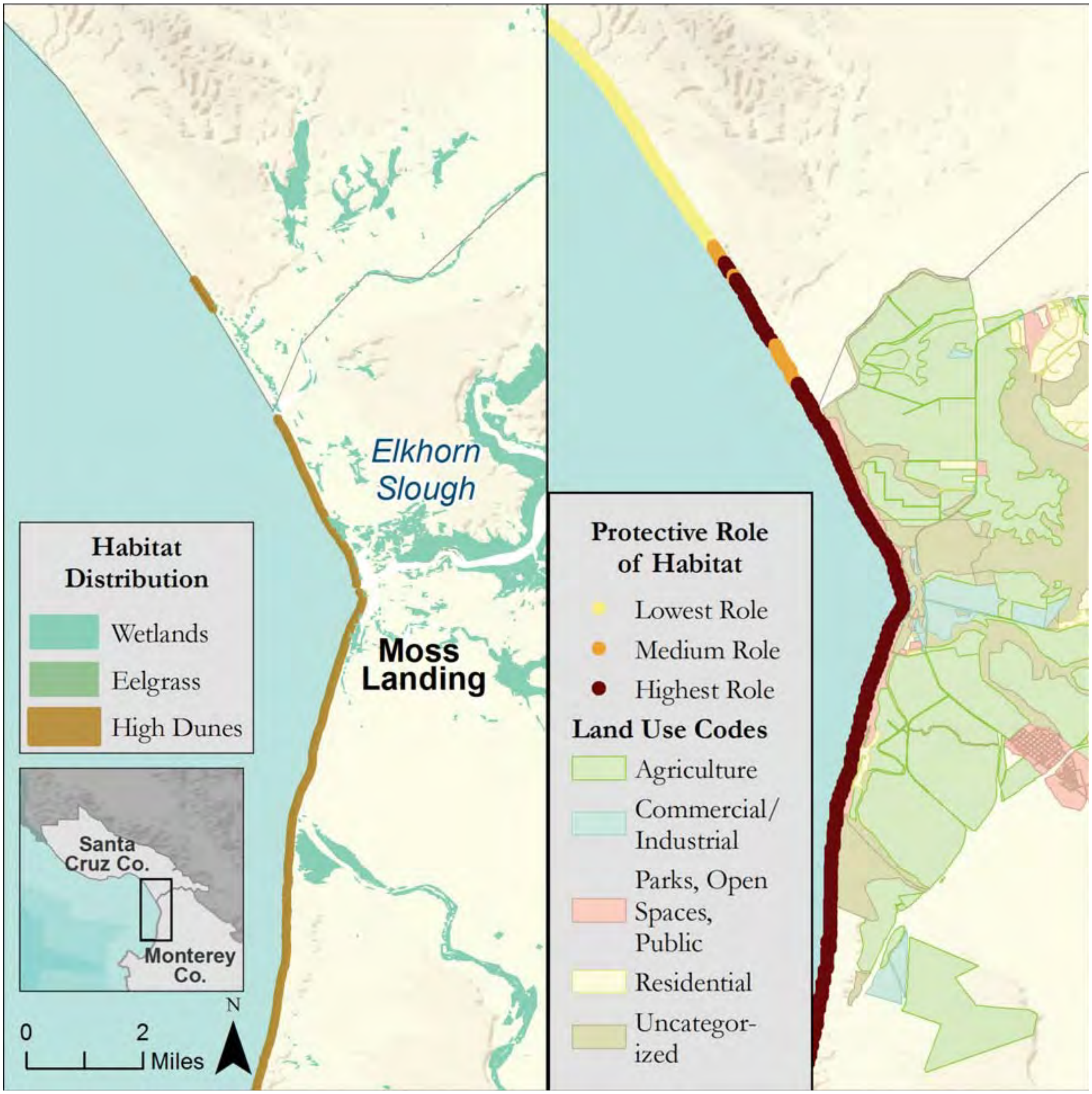

Fig. 7: Coastal habitats around Moss Landing, CA (Left). The relative role of coastal habitats near the mouth of Elkhorn Slough in reducing exposure to erosion and inundation with relevant land use zoning information (Right). Zoning information was distilled using the same methodology used for Capitola (Fig. 5).

<u>Moss Landing: Ecosystem Services of Coastal Habitats</u>

Coastal Dune and Beach Systems

The relatively dry areas on the high beach behind dunes are sheltered from wind and spray, serving as nesting grounds for endemic shorebirds and haul out spots for marine mammals. These beaches provide opportunities for coastal recreation, fishing, and wildlife viewing in the surrounding area in addition to their role protecting the coastline from high energy waves.

Elkhorn Slough

The estuarine system of Elkhorn Slough is the largest marsh habitat in California outside of San Francisco Bay and provides critical habitat for shorebirds and fishes. This area has also been home to a suite of competing human uses for more than 150 years (e.g., agriculture, cattle grazing, railroad and road construction, fishing, municipal energy production, marine research, tourism, recreation) that have led to the historical development of engineered structures (e.g., levees, embankments) and the construction of Moss Landing Harbor at the mouth of the estuary. These engineered structures have significantly influenced the structure and function of the estuarine system.[69] While the wetland systems in Elkhorn Slough are an ecologically and economically important feature of the area, they are also at risk due to a squeeze between rising sea levels and little room to migrate inland.[70]

Wetland habitats provide a number of key ecosystem services beyond coastal protection, including carbon sequestration, water quality improvement, flood abatement and biodiversity support.[71] The sheltered estuarine waters and seagrass meadows within the slough serve as a nursery for juveniles of commercially important fish species.[72] Elkhorn Slough is one of the few remaining freshwater and saltwater resting stops on the Pacific flyway. The slough is a critical habitat for migratory bird species and was designated a globally important bird area in 2000.[73] The banks of the Slough also serve as a major haul out area for marine mammals.

Additionally, wetland habitats store large amounts of carbon in their submerged soils when kept intact and have the potential to be used for carbon sequestration on the scale of decades or longer.[74] On a more immediate time scale, coastal vegetation helps buffer against ocean acidification by removing carbon dioxide from the water.[75] As larval fish and invertebrates experience more harmful effects from acidifying water conditions than adults, the wetlands and marshes of Elkhorn Slough may aid in protecting important species from harmful water chemistry in addition to protecting them from predators.[76]

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[69] Eric Van Dyke & Kerstin Wasson, *Historical Ecology of a Central California Estuary*: *150 Years of Habitat Change* 28 ESTUARIES 173, 179 (2005); *see also* CHANGES IN A CALIFORNIA ESTUARY: A PROFILE OF ELKHORN SLOUGH (Jane Caffrey et al. eds., 2002).

[70] Kerstin Wasson et al., *Ecotones as Indicators of Changing Environmental Conditions: Rapid Migration of Salt Marsh–Upland Boundaries* 36 ESTUARIES AND COASTS 654 (2013).

[71] WORLD RESOURCES INSTITUTE, ECOSYSTEMS AND HUMAN WELL-BEING: WETLANDS AND WATER SYNTHESIS (2005) (a report of the Millennium Ecosystem Assessment).

[72] Michael Beck et al., *The identification, conservation, and management of estuarine and marine nurseries for fish and invertebrates* 51 BIOSCIENCE 633 (2001).

[73] CHANGES IN A CALIFORNIA ESTUARY: A PROFILE OF ELKHORN SLOUGH, *supra* note 23.

[74] Cloern et al., *supra* note 24; McLeod, *supra* note 49.

[75] Hendriks, *supra* note 26.

[76] Haruko Kurihara, *Effects of CO2-driven ocean acidification on the early developmental stages of invertebrates* 373 MARINE ECOLOGY PROGRESS SERIES 275 (2008); Philip Munday et al., *Replenishment of fish populations is threatened*

Wetland habitats are threatened in the Elkhorn Slough area—and throughout the state—due to increased erosion from rising sea levels and land use development (agricultural, urban and/or rural). Fertilizer from agricultural runoff contributes to eutrophication and massive algal blooms that smother native flora, while urban pollutants may impair water quality.[77] Wetlands and coastal dunes that are exposed to coastal hazards could potentially migrate upslope given a path free of barriers from coastal development or shoreline hardening.

Moss Landing: Adaptation Strategies & Considerations

Coastal Adaptation Options

Moss Landing's coastline lends itself to several nature-based adaptation strategies. For instance, because the dunes in the area play a large role in protecting Moss Landing's coastline, adaptation strategies that protect, restore and enhance these areas could be targeted to maintain the integrity of the area. A dune restoration and enhancement project currently provides protection for MBARI. Additional suitable areas for dune restoration in Moss Landing could be identified and prioritized based on the protective role of specific dune habitats as well as factors specifically relevant to the local planning community. Beach nourishment might also be used to stem beach loss and to buffer these important dunes from erosion. Wetland restoration is another nature-based solution possible for Moss Landing. Wetland restoration in the area would carry various possible co-benefits including: sequestration of carbon dioxide, maintaining these areas as corridors for gradual coastline retreat and providing protection against storm surges.

Other nature-based options might be suitable here as well. Conservation easements could be implemented in some of these areas, particularly those most vulnerable to rising seas. This strategy involves either paying a landowner not to develop vulnerable land, or the landowner agreeing to do so without compensation, or in exchange for some other incentive, such as a tax break. This strategy would ensure that undeveloped lands stay undeveloped, and it could help transition currently developed but threatened lands to undeveloped lands. Rolling easements are another attractive but controversial option.[78] These can be used to allow the sea to migrate inland while slowly requiring the removal of structures within some distance of the approaching sea.[79]

In addition to the nature-based options outlined above, Moss Landing's coastline might also be suitable for other coastal adaptation strategies. For instance, accommodation and armoring might be appropriate for Moss Landing because it features a number of coastal dependent structures, such as the Monterey Bay Aquarium Research Institute, the Moss Landing Marine Laboratories, the Moss Landing power plant, and various boating and fishing facilities. Any of these structures might be protected or raised, depending on building design and construction, the anticipated

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by ocean acidification 107 PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCE OF THE UNITED STATES OF AMERICA 12930 (2010).

[77] Brent Hughes et al., *Recovery of a top predator mediates negative eutrophic effects on seagrass* 111 PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES 36444 (2014).

[78] *See generally* Meg Caldwell & Craig Holt Segall, *No Day at the Beach: Sea Level Rise, Ecosystem Loss, and Public Access Along the California Coast*, 34 ECOLOGY L.Q. 533, 535 (2007) (explaining that a rolling easement is "a device, rooted in statutory or common law or in permit conditions, that allows the publicly owned tidelands to migrate inland as the sea rises, thereby preserving ecosystem structure and function.").

[79] JAMES G. TITUS, ROLLING EASEMENTS (2011) *available at* https://www.epa.gov/sites/production/files/documents/rollingeasementsprimer.pdf.

building life cycle, end of use, and planned deconstruction. Furthermore, because of the various coastal-dependent buildings in the area, moveable structures could be installed and moved as needed in order to keep these structures on the coast as needed.

Other options can be pursued for undeveloped parcels in the area and existing structures that are not coastal dependent. Highway 1 could be moved inland or raised.[80] As was discussed for Capitola, an overlay zone could provide notice to the owners of vulnerable properties and restrict building and redevelopment in the area, as deemed appropriate. Furthermore, a moratorium on development could be imposed for some certain time period, while proactive coastal planning is pursued.

Moss Landing has a large amount of surrounding undeveloped and agricultural land.[81] Accordingly, some of these open spaces may be appropriate, stable sites for managed retreat of buildings in the area. Buyouts might be necessary in certain areas where planning is not able to sufficiently address increasingly rising seas.[82] Transfers of development rights might also be appropriate in certain similar circumstances.[83]

Barriers and Considerations

This area of the coastline is dominated by water, protected areas and sensitive ecosystems. The abundance of seawater and wetland areas might pose challenges for coastal adaptation for several reasons. For instance, the abundance of inland waterways and wetlands means that there is not much land immediately upland to move vulnerable buildings via managed retreat. Additionally, while this area features many coastal dependent facilities that might be protected or raised, there are drawbacks to pursuing these strategies. For instance, raising structures might bring additional regulatory requirements, such as those imposed by the Americans with Disabilities Act.[84]

Developing coastal adaptation strategies for coastal dependent structures carries with it its own set of unique challenges. Coastal dependent structures are prioritized for coastal land use under the Coastal Act.[85] Coastal dependent structures are not a high priority to move upland because of their dependence on water, but they need to be protected from rising seas nonetheless. Leaving these coastal dependent assets where they are makes them more susceptible to massive storm events than slowly rising seas. However, protecting these structures by armoring with seawalls would exacerbate erosion around these protective structures. If these coastal dependent structures are armored in the short term, long-term plans should be made to remove the armoring and move the structures.

Moving or raising Highway 1 presents issues as well. While raising Highway 1 in place is a possible short-term solution, Highway 1 may eventually need to be moved inland due to rising seas and repeated storm events. Moving Highway 1 immediately landward of its current location also presents drawbacks. Inland relocation would put it right in the middle of protected areas such

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[80] The issues with this proposition are discussed *infra* in the Barriers and Considerations section.
[81] *See* Figure 7.
[82] *See, e.g.*, New York's Recreate NY Smart Home Buyout Program.
[83] *See, e.g.,* Penn Central Transportation Co. v. New York City, 438 U.S. 104 (1978).
[84] 42 U.S.C. §§12101-12213.
[85] CAL. PUB. RES. CODE §§ 30235 & 30255.

as Elkhorn Slough[86] and could restrict coastal access.[87] Moving Highway 1 would also require CalTrans to exercise its eminent domain authority, which can be controversial. Finally, moving Highway 1 to upland areas, such as those currently used for agriculture, will introduce additional complexities because of how these lands are currently prioritized in the current LCP.[88]

Managed retreat faces several challenges in this area. While Moss Landing is surrounded by open area, much of the region comprises wetlands or otherwise sensitive or protected areas. For instance, the area features Elkhorn Slough State Marine Conservation Area, Elkhorn Slough State Marine Reserve, Moro Cojo Slough State Marine Reserve, Moss Landing State Beach, and the Moss Landing Wildlife Area. The abundance of state lands and conservation lands creates challenges for managed retreat. On the other hand, public and open spaces might be well-suited for conservation easements such that they are set aside to become inundated and form new wetland and marsh areas. Section 30240 of the Coastal Act protects environmentally sensitive habitat areas (ESHAs), and further complicates using any of the areas surrounding these protected areas in Moss Landing for managed retreat.[89]

Another issue is possible challenges to zoning changes in the area. Property owners affected by new regulations sometimes claim that these regulations impermissibly "take" their property without just compensation. As was the case for Capitola, local governments should be weary of enacting regulations that possibly deprive property of all of its economic value and of instituting moratoria that do not specify end dates.

<u>Summary</u>

Communities in the Monterey Bay region, like many areas of California and the nation, are actively planning for a changing climate. Rising sea levels and increasingly damaging storm events are expected to cause increased erosion and inundation, which will further threaten people, property, infrastructure and coastal habitats. If these habitats are lost, degraded or unable to adapt by migrating inland, then local communities also lose the beneficial services they provide, including carbon sequestration, improving water quality, buffering ocean chemistry, providing nursery or nesting grounds, and protecting from erosion and inundation.

Proactive adaptation planning that takes into account the role of coastal habitats—coupled with advanced construction designs and technologies—and policy pathways for implementation, will allow local communities to proceed from planning to implementation more effectively. Ultimately, this approach—in concert with similar coastal adaptation decisions throughout California—can lead to coastal management processes that are consistent for statewide needs and flexible for local needs while ensuring a vibrant coastline for future generations.

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[86] *See* list of protected areas in region *supra* note 15.
[87] The Coastal Act seeks to protect and maximize public coastal access. CAL PUB. RES. CODE. § 30211.
[88] MONTEREY COUNTY, NORTH COUNTY LAND USE PLAN 45-49 (1982).
[89] CAL. PUB. RES. CODE § 30240.

Habitat Type	Relative Protective Role*	Protective Attributes	Additional Ecosystem Services	Management Options
Kelp Forests	Relatively Low Role	Kelp forests attenuate low-energy wave action and have a dimished protective role as wave power increases.	Habitat for commercially viable fish and invertebrate species	Maintain healthy water conditions for kelp growth and reproduction.
			Vegetation harvested for commercial abalone aquaculture	
			Nutrient and vegetation export to local beach ecosystems	
			Integral ecosystem for culturally important species	
Wetlands	Relatively Moderate Role	Wetland ecosystems absorb water to reduce inundation and also serve to dissipate wave energy.	Flood control from inland inundation	Consider conservation of key areas of vegetation and soils before allowing development.
			Nutrient and sediment retention for improved water quality	
			Habitat for diverse species including marine mammals	Provide space for habitat to migrate inland as sea level rises.
			Carbon sequestration	
Seagrass	Relatively Low Role	Eelgrass beds attenuate low-energy waves which help decrease erosion of loose soils.	Wave attenuation	Provide space for habitat to migrate inland as sea level rises.
			pH buffer	Conserve existing habitat and restore damaged submerged aquatic vegetation.
			Nursery and essential habitat for fish and invertebrate species	
			Carbon sequestration	Maintain healthy water conditions and limit habitat degradation.
High Dune Systems**	Relatively High Role	Large dune systems dissipate high-energy waves and resist runup from powerful storms.	Cultural and aesthetic attachment	Maintain dune structure and vegetation.
			Location for recreation	
			Habitat for important bird and plant species	Regulate and/or limit dune sediment extraction.
Low Dunes & Beaches**	Relatively Moderate to High Role	Low dune systems and beaches dissipate low and moderate energy waves.	Habitat for important bird and plant species	Limit the implementation of built structures that impede migration of beach systems.
			Location for recreation	
			Cultural and aesthetic attachment	Maintain beach structure and access to continued sediment supply.

Table 1: Compilation of Ecosystem Services

*Protective role is based on model outputs created for and relative to the full study area (Año Nuevo to Wharf 2).
**Dunes were classified as “high dune” if their crest was higher than five meters. High dunes are less likely to lead to overwash and inundation from coastal storms.

Adaptation Strategy	Definition*	Example**	Potential Applications	Role of Natural System
Protection: *Hold the Line*	Employ built measure to defend development in current location	Wetland Restoration	Elkhorn Slough; northern section of Moss Landing Harbor; potentially in creeks near Capitola	Enhances extent of ecologically important natural areas
		Dune Restoration	North and south of Moss Landing on outer coast; southern Monterey Bay	Enhances extent of ecologically important natural areas
		Beach Nourishment	Soquel Creek Lagoon; outer coast of Moss Landing	Adds to natural system; requires thorough environmental monitoring
		Hard Protection	Near coastal-dependant or critical infrastructure such as power plant or critical transportation routes	Often limits natural habitat migration and increases erosion at edges of armoring
Accommodation: *Adjust to the line*	Modify existing or new development to decrease hazard risks	Overlay Zones	Existing flood zones or areas expected to be impacted by rising sea levels	N/A
		Limit Redevelopment	Locations that encounter repetitive loss or in (newly delineated) sea level rise overlay zones	May facilitate migration of natural systems or allow them to reestablish themselves
		Mobile Structures	Structures that are location dependent yet also encounter large episodic flood events	N/A
		Conservation Easement	Open and undeveloped areas in existing flood plain and areas adjacent to flood plains	Keeps natural system intact
Retreat: *Get away from the line*	Relocate existing development out of hazard areas and/or limit construction of new development in vulnerable areas	Planned Retreat	Highly vulnerable areas or locations with suitable upland areas available nearby	Removes structures allowing corridor for habitats to naturally migrate inland
		Buyout Programs	Lands suitable for becoming open areas	Can help promote natural system to replace previously developed area
Hybrid: *Maintain a flexible line*	Using strategies from multiple categories that may need to change over time	Accommodate over short term; relocate over long term	Hybrid adaptation options could be designed with enough flexibility to be applied across many different areas as needed	Provides pathway for taking actions that allow habitat to migrate and may provide opportunities for nature-based solutions
		Update land use designations and zoning ordinances		
		Redevelopment restrictions		
		Permit conditions		

Table 2: Compilation of Adaptation Strategies

* Definitions of adaptation strategies are distilled explanations derived from chapter seven of the California Coastal Commission's Sea Level Rise Guidance (Guidance).

** Many examples are summarized descriptions from figure 17 of the Guidance.

Analysis, Methodology, and Assumptions

This assessment involved a combination of ecosystem service modeling and adaptation policy research in an effort to identify and map priority locations for nature-based strategies that reduce vulnerability of critical assets using feasible land use policy methods.

To map and value the goods and services from natural habitats, we used the InVEST (Integrated Valuation of Environmental Services and Tradeoffs) free and open-source suite of software models created by the Natural Capital Project at Stanford University. The InVEST Coastal Vulnerability model incorporates a scenario-based approach to evaluate the role of natural habitats in reducing exposure to coastal impacts. [90] The InVEST Coastal Vulnerability model produces a qualitative estimate of coastal exposure. The Exposure Index differentiates areas with relatively high or low exposure to erosion and inundation during storms.

Data inputs included: 1) **Geomorphology**: Polyline representing coastal geomorphology based on the National Oceanic and Atmospheric Administration (NOAA) Environmental Sensitivity Index; 2) **Coastal habitat**: Polygons representing the location of natural habitats (e.g., seagrass, kelp, wetlands, etc.) from the Department of Fish and Wildlife website created for Marine Life Protection Act process; 3) **Wind and wave exposure**: Point shapefile containing values of observed storm wind speed and wave power across an area of interest using Wave Watch III data provided by NOAA; 4) **Surge potential**: Depth contour that can be used as an indicator for surge level default contour is the edge of the continental shelf. In general, the longer the distance between the coastline and the edge of the continental shelf at a given area during a given storm, the higher the storm surge; 5) **Relief**: A digital elevation model (DEM) representing the topography and (optionally) the bathymetry of the coastal area—this analysis includes a five meter bathymetric and topographic merge from US Geologic Survey for the California coast; 6) **Sea-level rise**: Rates of (projected) net sea-level change derived from the National Research Council 2012 report (highest range for 2030: 12" of sea level change);[91] 7) **Hard Armoring**: Data set inventory of man-made structures and natural coastal barriers that have the potential to retain sandy beach area in California. This armoring dataset is a compilation of the UC Santa Cruz Sand Retention Structures, Monterey County Barriers, and US Army Corps of Engineers Coastal Structures.

One main limitation with this modeling approach is that the dynamic interactions of complex coastal processes occurring in a region are overly simplified into the geometric mean of seven variables and exposure categories. InVEST does not model storm surge or wave field in nearshore regions. More importantly, the model does not take into account the amount and quality of habitats, and it does not quantify the role of habitats for reducing coastal hazards. Also, the model does not consider any hydrodynamic or sediment transport processes: it has been assumed that regions that belong to the same broad geomorphic exposure class behave in a similar way. In addition, using this model we assume that natural habitats provide protection to regions that are protected against erosion independent of their geomorphology classification (e.g., rocky cliffs). This limitation artificially deflates the relative vulnerability of these regions, and inflates the relative vulnerability

[90] INTEGRATED VALUATION OF ECOSYSTEM SERVICES AND TRADEOFFS, http://www.naturalcapitalproject.org/models/coastal_vulnerability.html (last visited Aug. 30, 2016).

[91] NATIONAL RESEARCH COUNCIL (NRC) COMMITTEE ON SEA LEVEL RISE IN CALIFORNIA, OREGON, AND WASHINGTON, SEA-LEVEL RISE FOR THE COASTS OF CALIFORNIA, OREGON, AND WASHINGTON: PAST, PRESENT, AND FUTURE (2012).

of regions that have a high geomorphic index. Based on these limitations and assumptions, the InVEST Coastal Vulnerability tool is an informative approach to investigate *relative exposure* for a coastline and identify locations where coastal habitats play a relatively significant role in reducing exposure. However, for local scale decisions regarding locally specific geomorphic conditions, further analysis is needed (e.g., the InVEST Nearshore Wave and Erosion model).

Results can help evaluate tradeoffs between climate adaptation strategy approaches. In this assessment, we compared the InVEST Exposure Index results both with and without the protective services provided by natural habitats. This approach (computing the difference between exposure indices) provides a priority index for locations in which coastal habitats play the largest relative role in reducing exposure to erosion and inundation. These locations can then be further investigated for nature-based strategies to reduce vulnerability.

We began our policy research by exploring academic and practitioner guidance on potentially appropriate coastal adaptation strategies for sea-level rise. We reviewed a number of guidance documents that outline land use planning and regulatory options that should be considered in coastal areas. Next, we identified how priority or high-risk locations align with various land-use or zoning designations in Monterey and Santa Cruz Counties using land use zoning layers provided by Monterey and Santa Cruz Counties as well as from planning staff from the City of Capitola. The zoning designations and population density in the various high-risk areas guided our determination of the strategies most feasible in each location. For example, high-density zoning designations—in most cases—reduce the feasibility of habitat restoration or retreat options. We also researched relevant state- and county-level laws and policies on acceptable strategies for near- and long-term adaptation to rising sea levels. We identified the limitations these policies place on adaptation options in the Monterey Bay Region and explored potential changes to the existing policies that may increase adaptive capacity. Ultimately, these prioritized policy considerations may be relevant to both Santa Cruz and Monterey Counties—as well as local jurisdictions—through the development of the Local Coastal Program update process.

In addition to this specific engagement in the Monterey Bay Region, the Center for Ocean Solutions is also involved in Local Coastal Program updates throughout the state. The Center is playing a key role in compiling, distilling, and distributing information on incremental adaptation actions with current county partners (i.e., Sonoma, Marin, Santa Cruz, and Monterey Counties) as well as with the State Coastal Conservancy and California Coastal Commission through the development of the California Coastal Adaptation Network. By developing a transferable methodology that incorporates the role of natural capital into county-level coastal adaptation planning, the Center for Ocean Solutions is scaling these best practices to a statewide prioritization of adaptation strategies that preserve the integrity of natural systems. The Center's work advances the state's efforts for flexible consistency in accordance with the California Coastal Commission's Sea Level Rise Policy Guidance.

Appendix B.

Climate Change Impacts to Combined Fluvial and Coastal Hazards (ESA, 2016)

MONTEREY BAY SEA LEVEL RISE

Climate Change Impacts to Combined Fluvial and Coastal Hazards

Prepared for
Moss Landing Marine Labs with Funding from the
California Ocean Protection Council

May 13, 2016

MONTEREY BAY SEA LEVEL RISE

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1 INTRODUCTION

As part of the Sea Level Rise study for the Monterey County Local Coastal Program (LCP) ESA simulated and mapped the potential inundation from extreme coastal and fluvial conditions for multiple scenarios of future climate conditions. Two fluvial systems were analyzed for this effort (1) the Reclamation Ditch watershed which includes Gabilan Creek and Tembladero Slough the and drains to the Moss Landing Harbor, and (2) Soquel Creek which runs through the City of Capitola in Santa Cruz County. The Reclamation Ditch watershed is mostly agricultural while the lower reaches on Soquel Creek are mostly urbanized. These two systems were selected to enable risk assessment for a range of natural and manmade resources.

Climate data analysis was conducted to evaluate future extreme rainfall-runoff events and extreme coastal tide and wave events. For the rainfall-runoff and fluvial climate change analysis ESA used public climate model data to develop medium and high estimates of 100-year discharge for 2030, 2060, and 2100 time periods. ESA also developed estimates of extreme tide conditions with sea level rise for medium and high climate change scenarios for the three future periods. The flood levels and extents were then estimated for these scenarios using hydraulic modeling driven by combined watershed and coastal water level conditions under climate stress.

The study developed geospatial datasets for the extent and depth of inundation under flooding for existing conditions and future climate scenarios. The key products and findings for this study include:

- **Key products developed**
  - GIS layers of flood inundation extent for the Moss Landing Harbor and surrounding areas, and Soquel Creek in Capitola, for six scenarios (1) existing conditions 100-year flood, (2) future conditions 100-year flood under high emissions for 2030, (3 and 4) medium and high emissions for 2060, and (5 and 6) medium and high emissions for 2100.
  - GIS depth rasters for both systems and the six scenarios listed above.
  - Amendments to previously developed coastal flooding layers based on newly surveyed structural information in flooded areas in Monterey Bay.
  - Technical metadata and reporting contained herein
- **Key analysis findings**
  - Analysis of existing hydrologic climate data indicates an increase in peak flow for the 100-year discharge of 337 cfs (25%) for high emissions by 2100 on the Reclamation

Ditch system and by 1660 cfs (95%) for Soquel Creek for the same emissions and time horizon scenario.

- Analysis of existing sea level rise trends and anticipated coastal flood levels indicate an increase in downstream water level of 5.2 ft for high emissions by 2100.
- As anticipated the increase in rainfall intensity and 100-year discharge combined with the increase in sea level under climate change increases flood extent on both systems. In comparing the 100-year event under existing conditions with the year 2100 high-emissions scenario, the increase in flood extent for the Reclamation Ditch system is approximately 1736 acres (95%) and the change in flood depth is approximately 2.6 feet (36%). The same comparison for Soquel Creek, which is more topographically constrained, shows a total increase in flood extent of 65 acres (65%) and an increase in flood depth of 3.01 feet (29%).

The following four report sections lay out the technical analysis methodologies, flood hazard mapping results, and applications for the resulting information in planning and adaptation assessments. Specifically Section 2 describes the climate analysis conducted to develop boundary conditions for the hydraulic model for several scenarios representing change in 100-year discharge due to increased precipitation intensity and depth with climate change and the change in extreme ocean level coincident with the 100-year flow. Section 3 describes the model development process for both the Reclamation Ditch and Soquel Creek systems. Section 4 summarizes the flood hazard mapping analysis conducted to develop the geospatial datasets of flood hazard for the climate scenarios analyzed. Section 5 summarizes the applicability of the datasets to planning and adaptation efforts for the communities that may be at risk of additional flooding under stress by climate change.

2 CLIMATE ANALYSIS

2.1 Emissions Scenarios

The goal of the climate change data analysis was to review existing climate model data to estimate changes in extreme rainfall, coastal water level, and the resulting extent of flood hazards. The changes in extreme rainfall conditions were used to drive the inflow boundary for the hydraulic models of the two systems. Climate model data were evaluated for the latest set of General Circulation Models (GCMs) developed for the IPCC's fifth Assessment Report (AR5). The GCM data produced for AR5 has been aggregated by the World Climate Research Programme under the Coupled Model Intercomparison Project Phase 5 (CMIP5). The emissions scenarios used to drive the GCMs for CMIP5 are referred to as Representative Concentration Pathways (RCPs). The highest scenario, RCP 8.5, reflects a track with little mitigative measures to reduce greenhouse gas emissions resulting in a net increase in radiative forcing of 8.5 W/m^2 by 2100 relative to pre-industrial conditions. A medium level emissions scenario, RCP 4.5, reflects a future wherein changes in technology and energy usage stabilize the increase in net radiative forcing to 4.5 W/m^2 by 2100. These emissions scenarios, RCP 4.5 and RCP 8.5, were used to reflect respectively medium and high emissions trajectories for this study. Existing conditions was also modeled which is representative of a low emissions scenario thus the scenarios selected effectively span low, medium, and high climate change conditions.

These emissions scenarios supersede the scenarios developed in the Special Report on Emissions Scenario (SRES) utilized for the IPCC's fourth Assessment Report (AR4) and used to drive GCMs for CMIP Phase 3 (CMIP3). In general, the RCP4.5 emissions scenario tracks closely with the prior SRES B1 scenario, while RCP8.5 tracks slightly above SRES A2. The following figure (Figure 1) compares the change in mean surface temperature for the SRES and RCP emissions scenarios.

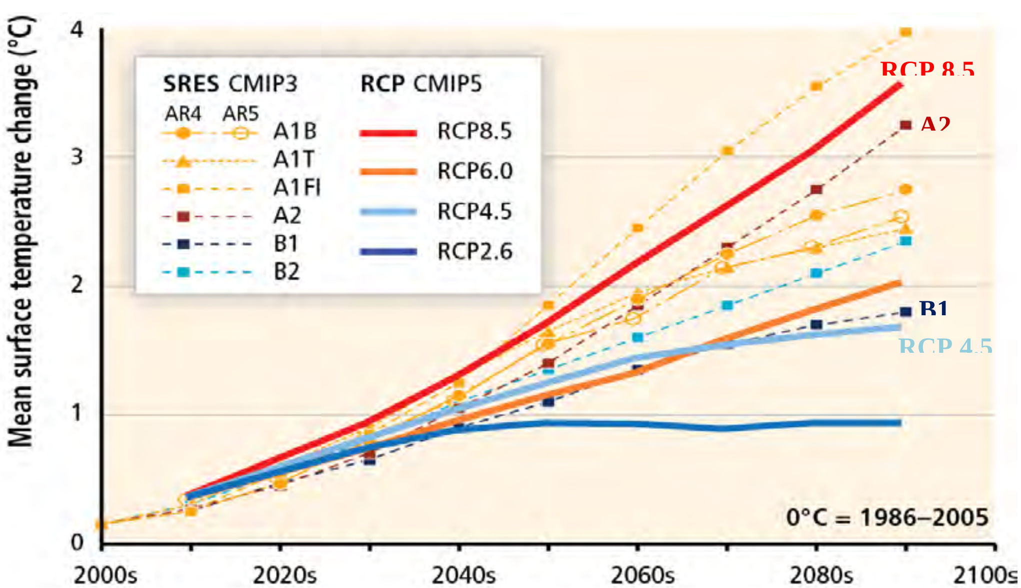

Figure 1. Comparison between SRES and RCP emissions scenarios. Reproduced from Figure 1-4 of IPCC AR5, WGII, Chapter 1

2.2 Extreme Fluvial Streamflow Analysis

Model output from GCMs driven by the RCP emissions scenarios was downscaled by CMIP5 institutions to regionalize the data from a global scale to higher resolution local scale. The downscaled data were then used to drive hydrologic models and estimate runoff for a daily timestep on a 12km x 12km grid from 1950-2100 in a study conducted by the USBR (2014). ESA used the resulting data from the USBR study to route baseflow and surface runoff and generate a time series of daily streamflow at the outlet of the two systems. The routing routine used is a component of the Variable Infiltration Capacity (VIC) model used in the USBR study to develop the runoff datasets.

The resulting daily streamflow time series from 1950-2100 was used to conduct flood frequency analysis to estimate 100-year discharge (Q_{100}) for medium and high emissions for 2030, 2060, and 2100. From the daily time series, peak annual flows were extracted for each year from 1950- 2100. A frequency curve was then fit to subsets of the peak annual flows using the Log Pearson III (LP-III) fitting method outlined in the USGSs Bulletin 17b (USGS, 1982). The USGS conducted a 2011 study updating many of the elements of Bulletin 17b based on updated gage records through water year 2006 for California gages (USGS, 2011). Two significant elements that were updated were the methods for estimating values for generalized skew (G_{gen}) and mean square error for generalized skew (MSE-G_{gen}) based on the average elevation of the basin. The average elevation of the basin is 479 feet for the Reclamation Ditch system and 1,141 feet for Soquel Creek. Based on the non-linear model for G_{gen} and the relationship between MSE-G_{gen} and average basin elevation summarized in USGS, 2011 Tables 7 and 8 respectively, the values estimated for G_{gen} and MSE-G_{gen} for the Reclamation Ditch watershed are -0.613 and 0.14, respectively, and -0.581 and 0.14 respectively for Soquel Creek.

Using these updated values in the LP-III method, we computed 100-year discharge for each GCM and each emissions scenario for an historical period, and three future time periods—2030, 2060 and 2100. A sample figure for the flood frequency curve for the historic time period for a single GCM for RCP4.5 is shown in Figure 2. Subsets of the data were selected for the time periods as summarized in Table 1.

TABLE 1
SUBSETS FOR TIME PERIODS USED IN FLOOD FREQUENCY ANALYSIS

Time period	Years for which peak annual flow was used in flood frequency analysis	Emissions scenario	GCM percentile	Resulting 100-year flow variable
2030	2015-2045	RCP 4.5 (medium)	50th	Q_{100}-2030-medium
		RCP 8.5 (high)	90th	Q_{100}-2030-high
2060	2045-2075	RCP 4.5 (medium)	50th	Q_{100}-2060-medium
		RCP 8.5 (high)	90th	Q_{100}-2060-high
2100	2070-2100	RCP 4.5 (medium)	50th	Q_{100}-2100-medium
		RCP 8.5 (high)	90th	Q_{100}-2100-high

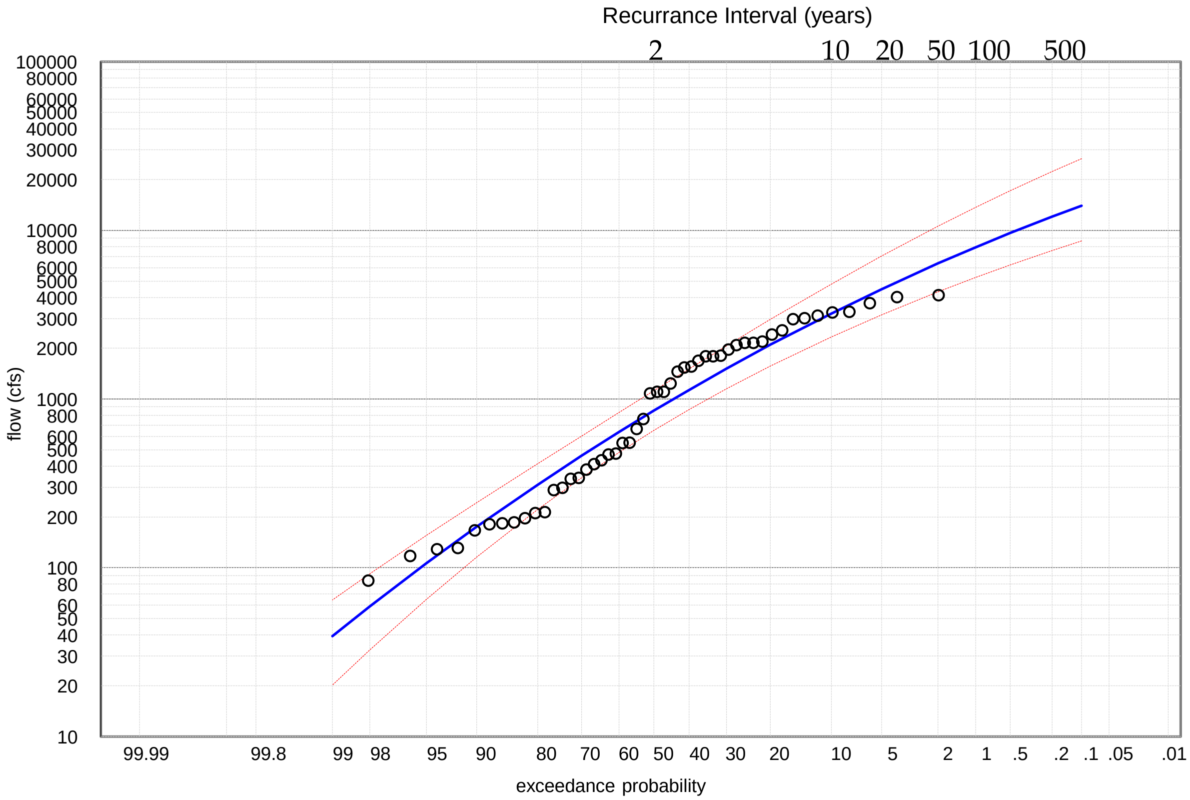

Figure 2. Log Pearson III flood frequency curve for historic time period (1950-2000) for GCM ACCESS[1] 1-0 for the RCP4.5 emissions scenario. The black dots show peak annual flow from routed GCM hydrology, the blue line shows the fitted LP-III curve, and the red lines show the 95- and 5-percent confidence intervals.

Because this analysis was conducted for each individual GCM, a distribution of GCMs can be created. The distribution highlights the discrepancy between individual models and the need to select a representative percentile for characterizing climate risk on any system. An example of the distribution of all models considered for a single emissions scenario and selected percentiles within the model distribution is shown for change in peak annual flow in Figure 3.

[1] Australian Community Climate and Earth-System Simulator (ACCESS)

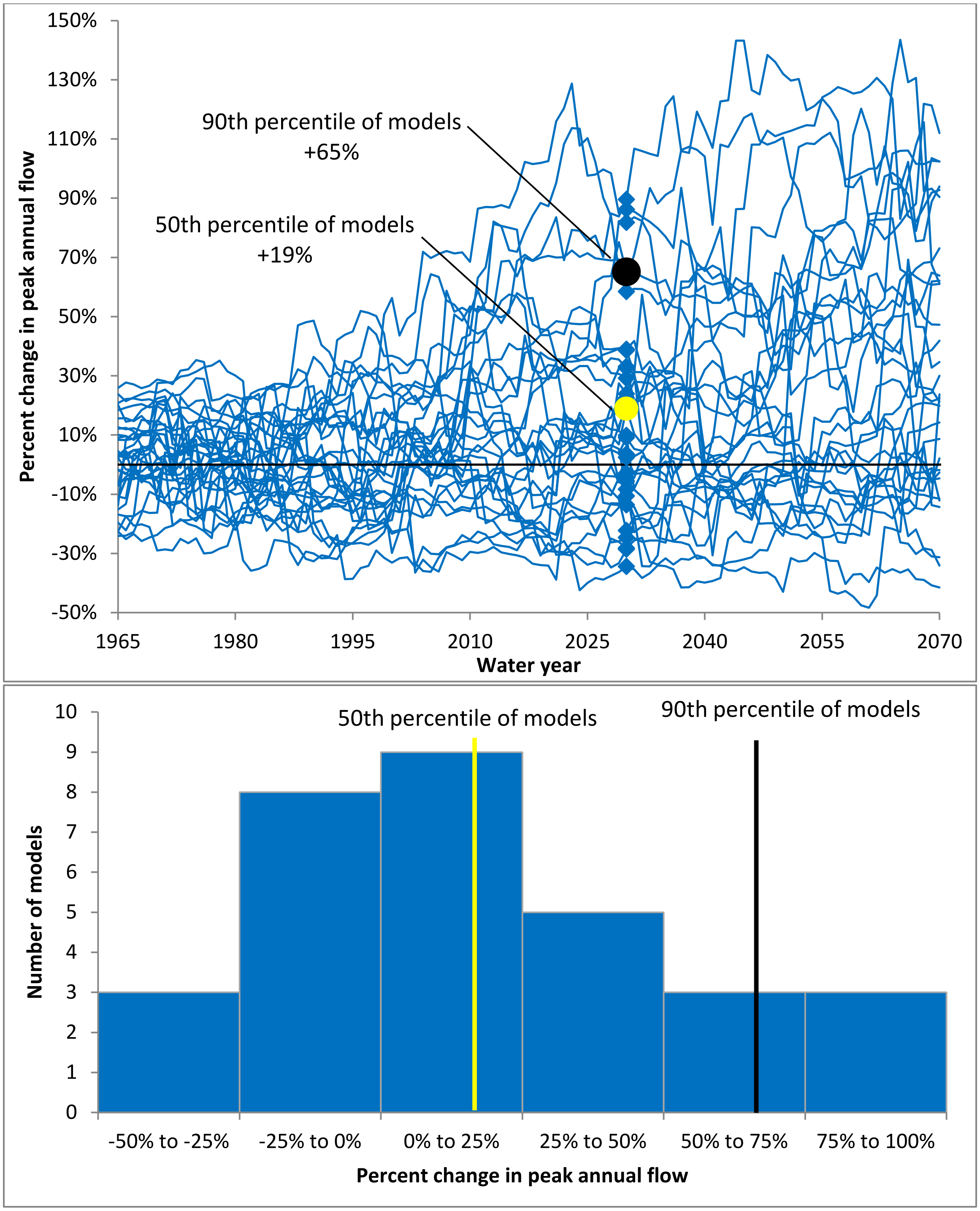

Figure 3. Percent change in peak annual flow relative to 1950-2000 average for all GCMs under RCP 4.5 emissions, blue lines show individual GCM trajectories and blue dots show result at year 2030 (top), and (bottom) histogram of total number of models for given ranges of percent change in peak annual flow

The 100-year discharge and the change in 100-year discharge for the three future time periods relative to the historic time period was calculated for each GCM based on the following equation:

$$\Delta Q_{100} = Q_{100-year-emissions} - Q_{100-hist}$$

Where ΔQ_{100} is the change in Q_{100} in cfs
$Q_{100\text{-year-emissions}}$ is the Q_{100} for a given GCM at a specific time horizon and emissions scenario
$Q_{100\text{-hist}}$ is the Q100 for the historical time period based on the GCM data

The distribution of GCMs for the change in Q_{100} on the Reclamation Ditch is shown for RCP 4.5 in Figure 4 and for RCP 8.5 in Figure 5. The distribution of GCMs for the change in Q100 on the Soquel Creek is shown for RCP 4.5 in Figure 6 and for RCP 8.5 in Figure 7.

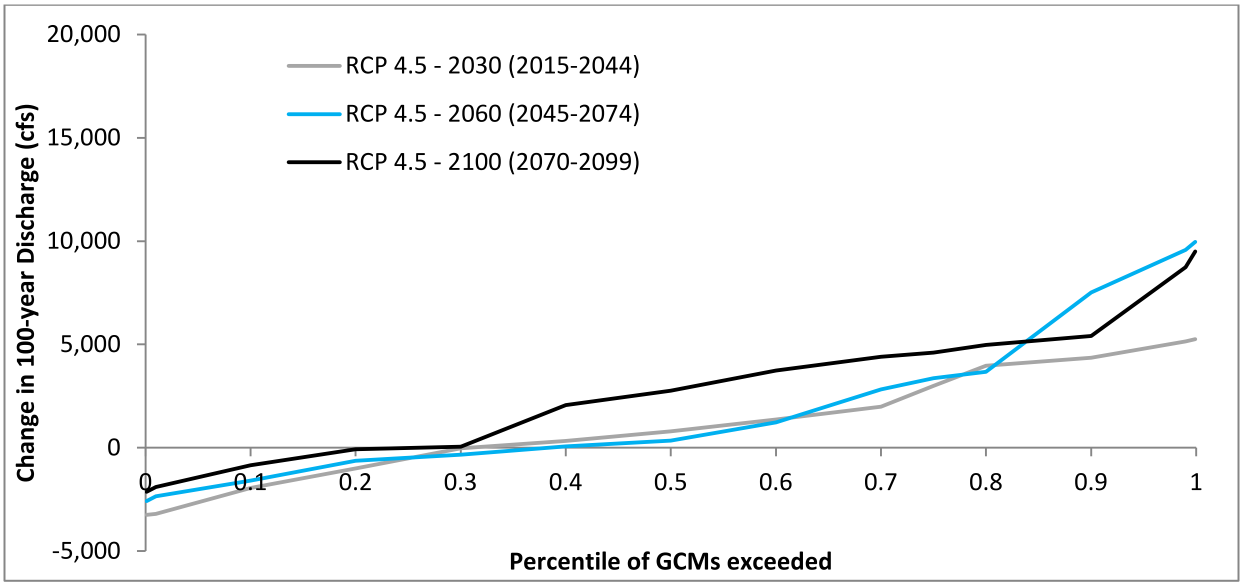

Figure 4. Distribution of change in Q_{100} for each GCM for 2030, 2060, and 2100 for RCP 4.5 on the Reclamation Ditch System

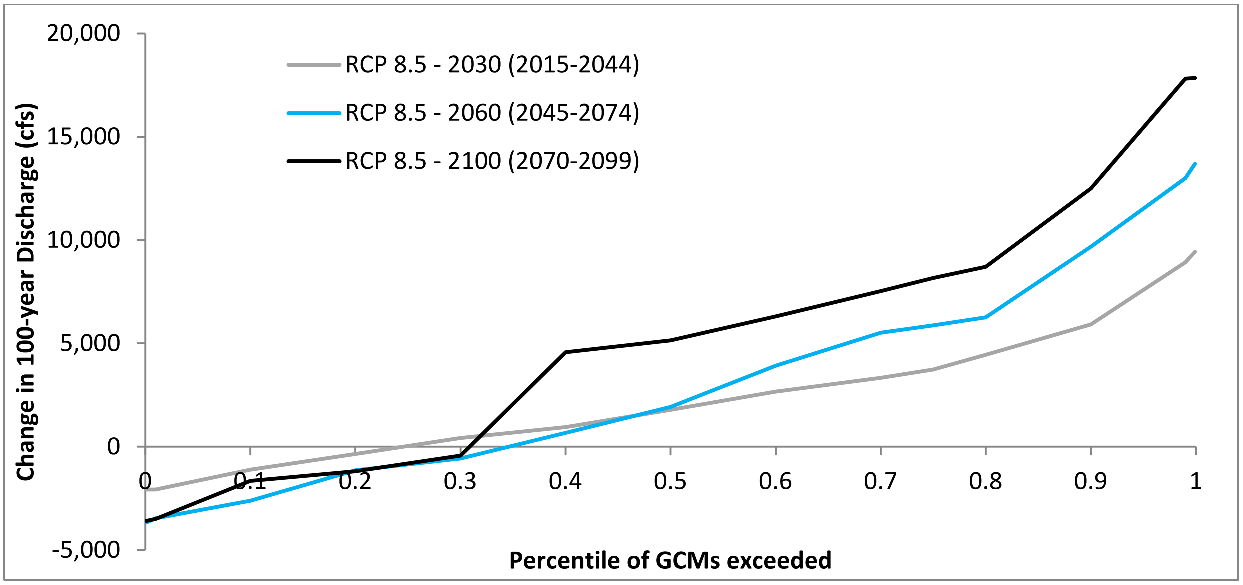

Figure 5. Distribution of change in Q_{100} for each GCM for 2030, 2060, and 2100 for RCP 8.5 on the Reclamation Ditch

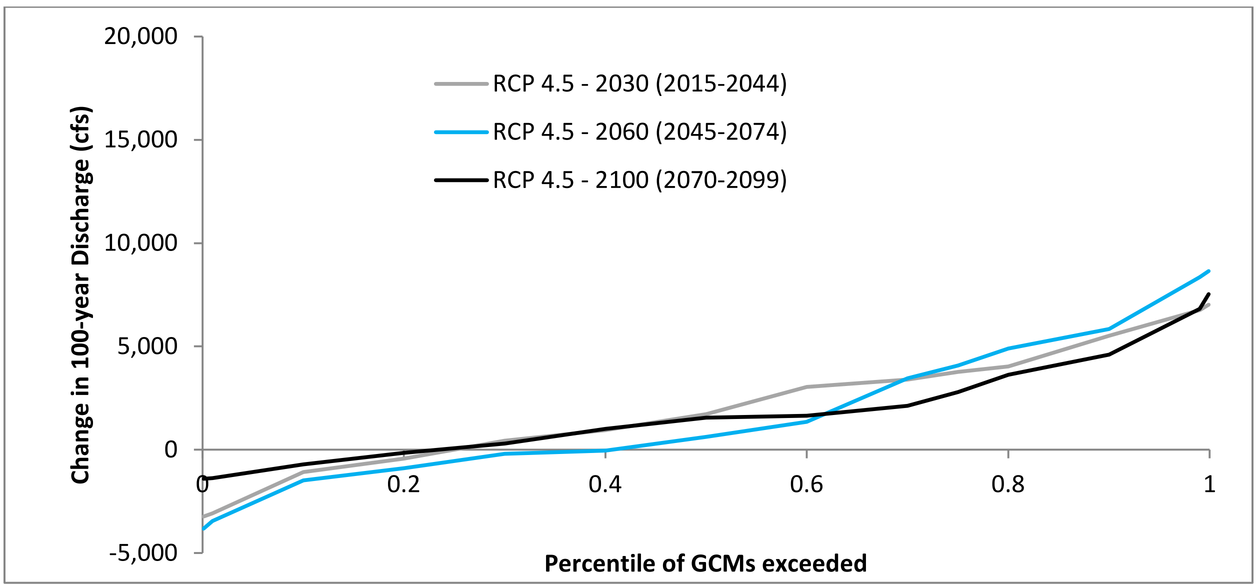

Figure 6. Distribution of change in Q_{100} for each GCM for 2030, 2060, and 2100 for RCP 4.5 on Soquel Creek

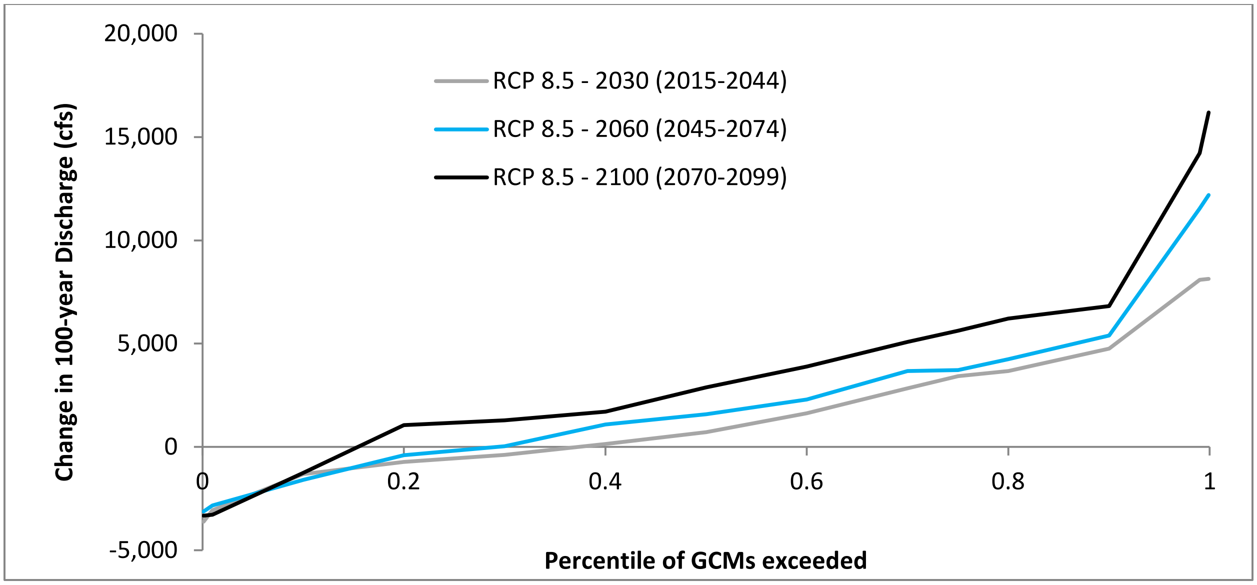

Figure 7. Distribution of change in Q_{100} for each GCM for 2030, 2060, and 2100 for RCP 8.5 on Soquel Creek

These figures indicate that for RCP 4.5, the emissions scenarios are grouped fairly closely for each future time period. The 'medium' emissions scenario was estimated from approximately the 50th percentile for the three time periods for RCP 4.5. It was determined that the 90th percentile of the models for RCP 8.5 for each individual year would be used to represent the 'high' emissions scenario. The changes estimated for 100-year discharge for both systems are summarized in Table 2.

TABLE 2
CHANGE IN 100-YEAR DISCHARGE FOR BOTH SYSTEMS RELATIVE TO HISTORIC PERIOD (1950-2000)

	Reclamation Ditch system			Soquel Creek		
Emissions scenario	**2030**	**2060**	**2100**	**2030**	**2060**	**2100**
Medium (RCP 4.5 50th percentile)	20%	40%	60%	13%	15%	20%
High (RCP 8.5 90th percentile)	140%	210%	275%	62%	68%	95%

The flows estimated in the extreme streamflow analysis were used to drive the hydraulic models which, in turn, were used to map inundation extents for existing conditions and the five future climate conditions (2030 high, 2060 and 2100 medium and high emissions). In addition to the extreme streamflow change, the downstream coastal water levels are influenced by sea level rise. The following section describes the analyses conducted to characterize the extreme coastal water level that would be coincident with the 100-year flood.

2.3 Extreme Coastal Water Level Analysis

2.3.1 Reclamation Ditch Extreme Tide Levels

The ocean boundary condition from the existing unsteady HEC-RAS hydraulic model consisted of a repeated tide cycle that peaked at about MHHW. To represent extreme tide conditions we used a 10-year tide as the ocean boundary for existing conditions. Given that the mouth of this system (the mouth to Moss Landing Harbor) is relatively deep we assumed that the mouth would not support wave setup, and therefore no additional water level increase was added for wave setup. The input ocean stage hydrograph was scaled up to peak at the 10-year water level (7.69 ft NAVD, from Monterey NOAA Buoy 9413450).

For future conditions the 10-year tide was increased at the rate of sea level rise based on the CA Coastal Commission guidance document (CCC, 2013). The total amount of SLR added for each scenario was estimated by fitting curves to the NRC 2012 SLR values, following this guidance. The peak tide elevation for each scenario is summarized in Table 3. These are the same water levels used by ESA for the Monterey Bay hazard mapping (ESA PWA, 2014).

TABLE 3
EXTREME TIDE CONDITIONS FOR RECLAMATION DITCH SYSTEM

	Sea level rise (ft)		10-year tide level + SLR (ft NAVD)	
Time period	Medium	High	Medium SLR	High SLR
2015	-	-	7.69	
2030	0.3	0.7	8.0	8.4
2060	1.1	2.4	8.8	11.0
2100	2.9	5.2	10.6	12.9

2.3.2 Soquel Creek Extreme Tide Levels

The Soquel Creek model is steady state thus there is no time dimension to the peak coastal water level. Recognizing this, it was deemed not representative to use the 10-year peak water level to represent extreme tide levels given that this elevation is only reached for a brief period during the 10-year event. We selected the 1-year recurrence interval as a tide level that would have a long enough time dimension to be considered credibly steady-state during an extreme tide event. Based on the Monterey Bay tide gauge (NOAA# 9413450), the 99% exceeded (1-year recurrence) tide elevation is 6.87 ft NAVD. Additionally, given the geomorphic configuration of this system, we added an additional increase in the steady state boundary to account for storm surge and wave setup. We selected 2-feet to account for these factors based historic data and previous studies of joint probability between coastal storm surge and high intensity rainfall as described below.

The steady downstream water surface boundary condition for Soquel Creek was chosen based on review of traditional practice and consideration of past analyses of joint probability of peak river discharges with elevated ocean water levels. A past study on San Lorenzo Creek by (USACE 2011) showed a correlation between peak discharges and storm surges, with average tidal residuals during river flood events ranging from 0.4 to 1.5 feet and wave setup ranging from 0.2 to 2 feet. We also examined historic data for Soquel Creek and nearby Aptos Creek for coastal storm events based on USGS stream gauge, CDIP buoy, and NOAA tide gauge records to estimate the wave setup during past events. We found similar patterns in the tide residuals, wave setup, and tide peak elevation during the storm. The wave setup and tide peak for a set of extreme tide and flow events is summarized in Table 4. The tidal peak water level that occurred around the time of the peak river discharge was found to be near the 1-year recurrence elevation with an average residual 0.5 feet and average estimated wave runup of 1.2 feet.

TABLE 4
COASTAL STORM SURGE AND WAVE SETUP FOR EVENTS ON SOQUEL AND APTOS CREEKS

Creek	Date	Approximate peak flow (cfs)	Ocean Residual ft (1-day average)	Offshore Wave Height, H (ft) approx	Wave Setup hsetup (ft)[1]	Total ocean water anomaly (wave setup + residual) ft	Tide Peak During Storm (ft NAVD)
Aptos	2/6/1983	210	0.74	16	1.6	2.38	6.1
Aptos	2/25/1983	210	0.43	11	1.1	1.58	6.9
Aptos	2/23/2009	280	-0.04	7	0.7	0.7	5.6
Aptos	1/20/2010	210	1.17	21	2.1	3.3	6
Aptos	12/21/2010	310	0.65	10	1	1.63	7
Aptos	12/29/2010	140	0.23	16	1.6	1.87	6.3
Aptos	2/25/2011	n/a	0.12	8	0.8	0.94	5.6
Soquel	10/13/2009	4000	0.85	7	0.7	1.51	6.1

[1]steady (average) setup ~= 0.1*H

The future conditions 100-year discharge combined with the future conditions extreme coastal tide level were used as boundary conditions for the hydraulic modeling analysis. The modeling analysis is described in the following section.

3 HYDRAULIC AND HYDRODYNAMIC MODELING ANALYSIS

3.1 Reclamation Ditch Unsteady Modeling

The basis for the unsteady HEC-RAS hydraulic model was a model provided by the Monterey County Water Resources Agency (MCWRA) to ESA in 2014. The model is an updated version of the HEC-RAS model originally developed by Schaaf & Wheeler (1999) for flood analysis. The model has been periodically updated for flood mapping studies. However, the original channel data dates back to the original study. The existing conditions 100-year hydrology was also developed by Schaaf & Wheeler in 1999 using a HEC-1 hydrologic model for the Gabilan Creek watershed. This formed the basis for the existing conditions 100-year unsteady hydrograph boundary conditions used in the model. Updates to the model geometry required including positioning the model in real geospatial coordinates and updating overbank areas with LiDAR topography are described in the following section.

3.1.1 Model Geometry Development

Hydraulic Roughness – The parameter representing the resistance to flow within a channel or floodplain due to vegetation, bedform, and bed material is known as the manning's roughness or 'n' value. The manning's n values were adopted from the existing model. The values are 0.025 for channel roughness and 0.065 for floodplain roughness.

Georeferencing – The original model provided by Monterey County required georeferencing to spatially orient the model input and output. The original mode was shifted to correctly orient the confluence of the Tembladero Slough and drainage canal from Merritt Lake (just upstream of Castroville). Tembladero Slough was digitized from Moss Landing up the Reclamation Ditch to the Hwy 101 crossing in Salinas using the HEC-GeoRAS toolbar in ArcGIS and then imported to the HEC-RAS model. Cross section spacing was then adjusted in HEC-RAS to align known bridge crossings with their spatial location. The model layout is shown in Figure 8.

Figure 8. Reclamation Ditch hydraulic model layout

Update with LiDAR – Because the overbank representation of the existing model was limited, it was necessary to update the overbank topography from new sources. This was accomplished by first extending the channel cross sections to include the full floodplain and then updating the cross section station-elevation data with topography from the 2009-2011 CA Coastal Conservancy Coastal Lidar Project: Hydro-flattened Bare Earth DEM that was downloaded from http://coast.noaa.gov/dataviewer/. This was only done for cross sections downstream of the railroad crossing west of Hwy 183, as the focus was primarily on flood behavior downstream. We determined that the elevations of the existing model were vertically referenced to an old vertical datum NGVD29. We thus converted the elevations to NAVD88 using the conversion factors listed in the FIS (+2.7 ft for Tembladero Slough, +2.77 ft for Reclamation Ditch). The model was also expanded into the Moro Cojo Slough and historic slough area between the Tembladero and Moro Cojo to represent alternate flood pathways that became apparent during the December 2014 flood.

Incorporation of MLML data – Hydraulic structure data was provided by Ross Clark, Charlie Endris, that was used to develop preliminary geometry for hydraulic structures located in the expanded portions of the model including:

1. Cabrillo Hwy crossing over Moro Cojo Slough

2. Moss Landing Rd tide gates at Moro Cojo

Other minor structure crossings in the model area were not accounted for due to lack of data. One improvement to the model would be to survey these crossings and add them into the model geometry to improve the representation of flow routing in the system.

3.1.2 Model Hydrology Inputs

Future flows determined in the future Q_{100} climate analysis were simulated by scaling the existing unsteady 100-year hydrographs that came with the HEC-RAS model provided by Monterey County. Base flow was maintained for the input hydrographs by only scaling the peak of each input hydrograph (flows > ~75% of the existing peak discharge). Within each hydrograph peak, a polynomial scaling function was used to produce smooth transitions between the existing rising and falling limbs and the future hydrograph peaks.

Inflow hydrographs were developed for Moro Cojo Slough and the unnamed canals/historic slough watershed. Area was determined for each watershed using USGS streamstats online tools. Then hydrographs were scaled from nearby subwatersheds analyzed by Schaff and Wheeler that possessed similar attributes (drainage area, relief, and impervious percentage) using watershed area as the scaling factor. These were scaled for future conditions using the method described above.

The downstream boundary was driven by an unsteady tide as described in the extreme coastal tide level section for the Reclamation Ditch.

3.1.3 Model Validation

The results of the updated hydraulic model run with the existing conditions 100-year hydrology and MHHW tailwater were compared to flooding extent and hydraulic flowpaths from a flood event that occurred in December 2014. The MLML provided a map of estimated extents and observed flow directions during this event. One key observation for this event was that flow backing up at the Moss Landing tide gates overtopped adjacent farm fields contributing additional water into Moro Cojo Slough which routes water to the harbor through the culverts under Moss Landing Road. The model reproduced this observed pattern for the 100-year flow as shown in Figure 9.

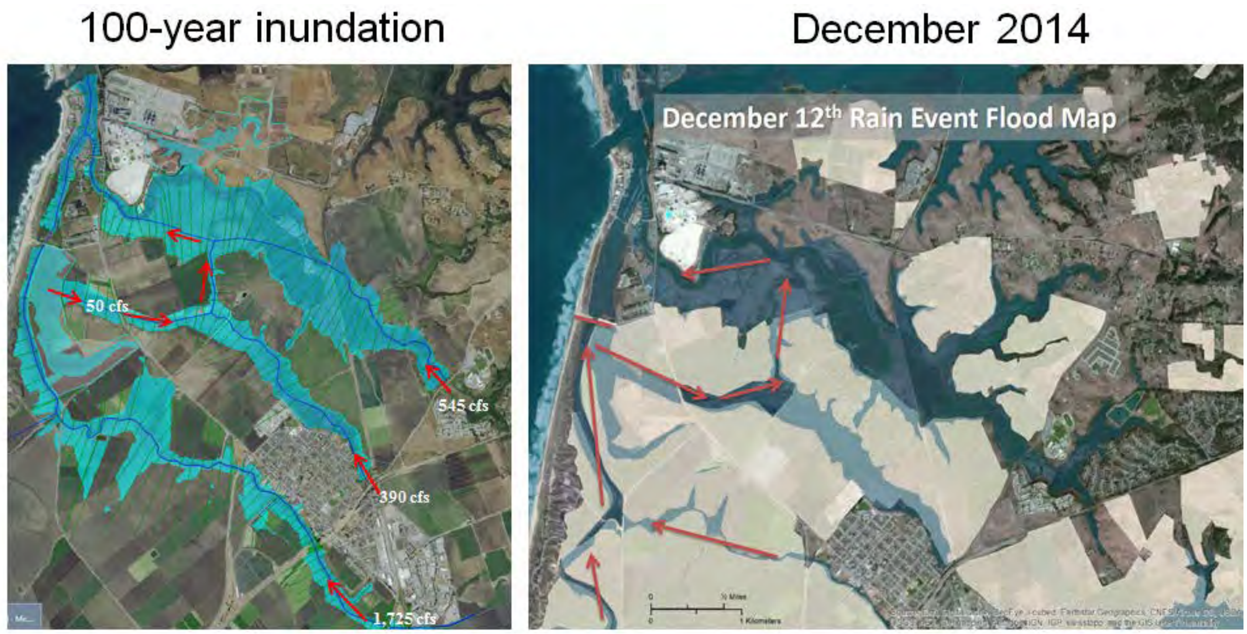

Figure 9. Comparison of Modeled 100-year flowpaths and observed flowpaths during December 2014 flood

3.1.4 Model Limitations

Flood mapping was truncated for Tembladero Slough at the Cabrillo Hwy, Moro Cojo up to the Railroad, and the historic slough in between. From the Tembladero up to the City of Salinas, the cross sections are limited to in channel portions, and floodplains were not mapped for any of the model coverage upstream. Given the uncertainty regarding the location of cross-sections an improvement to the model would be collecting new channel cross-sections and channel bathymetry in the model domain. Additionally, replacing the overbank areas with 2D flow elements would improve the routing of flow once it escapes the channel and goes out of bank. Lastly, the main Salinas River channel is not represented in the model. There are known interactions with the Salinas River and the Reclamation Ditch system including breakout flows from upstream entering the Reclamation Ditch and a water control structure connection between the mouth of the Salinas River and the old Salinas River alignment. The model could be improved significantly by combining the model with a model of the Salinas River and replacing the overbank areas with 2D flow elements.

3.2 Soquel Creek Steady State Modeling

3.2.1 Model Geometry Development

Hydraulic Roughness – The manning’s n values were adopted from the existing FEMA model to maintain consistency. The channel and floodplain n values are 0.1 and 0.4 respectively.

Georeferencing – The existing conditions model for Soquel Creek came from the effective FEMA model for the system which was provided by FEMA as HEC-2 data-the precursor to HEC-RAS. The model was converted to HEC-RAS and georeferencing was performed to geospatially orient the model cross-sections and flood results. The georeferencing was accomplished by digitizing the length of Soquel Creek from the Pacific Ocean upstream to the limit of existing model coverage with HEC-GeoRAS tools in ArcGIS. Once the new stream centerline was imported to HEC-RAS, cross section spacing was adjusted to align bridge crossings with the known locations determined by the Terrain or aerial imagery. The model cross-section layout is shown in Figure 10.

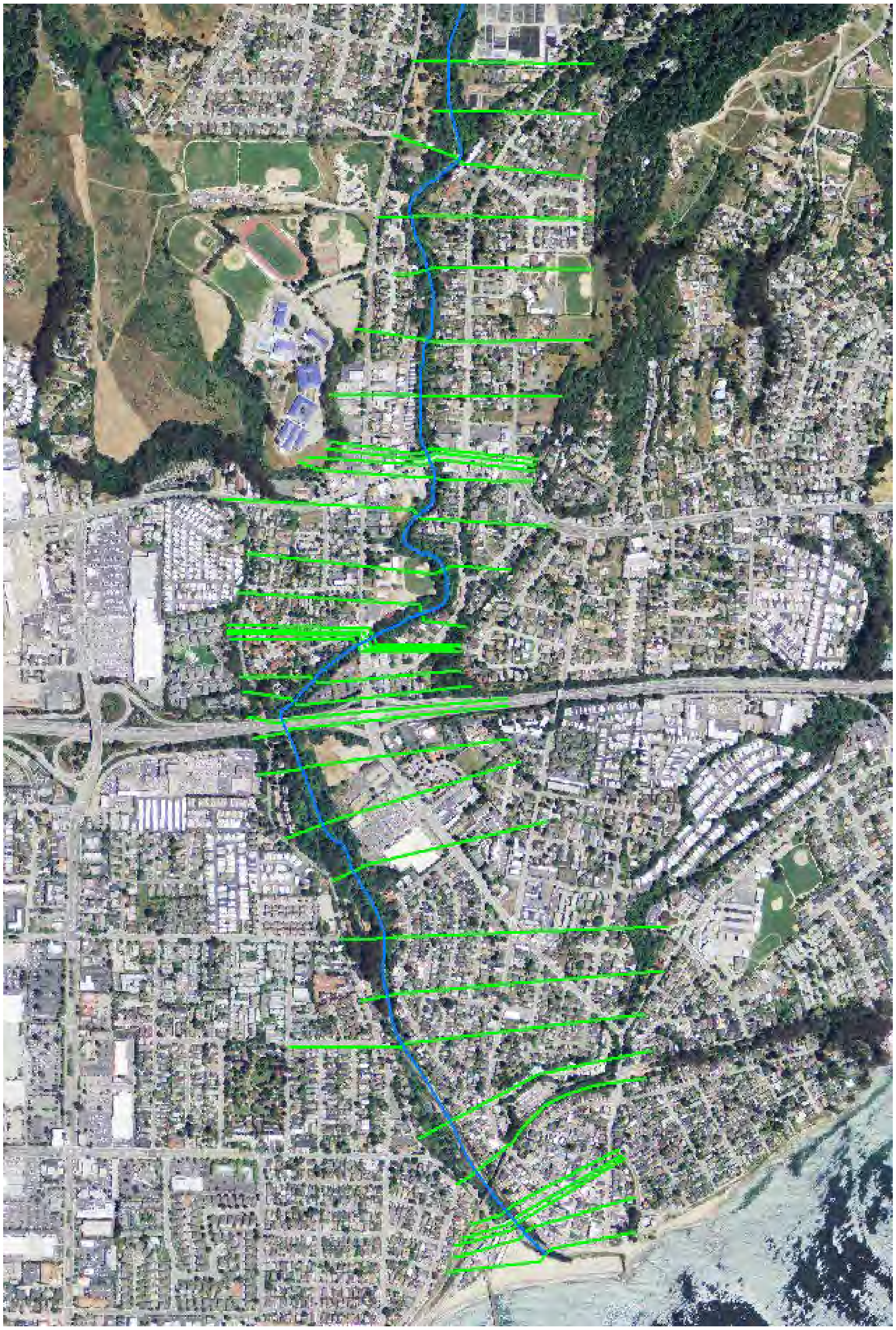

Figure 10. Soquel Creek hydraulic model layout

Update with LiDAR – Channel cross sections were extended to include the full floodplain and the cross section station-elevation data was updated with topography from the 2009 - 2011 CA Coastal Conservancy Coastal Lidar Project: Hydro-flattened Bare Earth DEM (downloaded here: http://coast.noaa.gov/dataviewer/). This was only done for cross sections downstream of Soquel Nursery Growers Plant Nursery. In-channel bathymetry and hydraulic structure data were maintained, and were shifted from NGVD29 to NAVD88 using the datum conversion factor from the FIS (+2.75 ft).

Incorporation of MLML data – Hydraulic structure data (stormdrains, manholes, etc.) were provided by Ross Clark, Charlie Endris, but were not used in the model. These data can (are going to) be used to update flood connectivity of previously mapped coastal flooding hazards (ESA 2014), and would serve to improve fluvial flood mapping from an unsteady model of Soquel Creek.

3.2.2 Model Hydrology Inputs

Future peak flows determined in the future Q_{100} climate analysis were modeled in steady state. Flows were increased by the percent change calculated for the medium and high emissions scenarios and the three future time horizons. The downstream boundary was driven by a steady tide as described in the extreme coastal tide level section for Soquel Creek.

3.2.3 Model Limitations

The geometry information in the model, including hydraulic structures and in-channel bathymetry, are out of date and may not be representative of current channel conditions. These should be updated to better represent the current conditions in Soquel Creek. Because the model is steady state, overbank flooding is potentially overestimated. Flooding extents could be improved by switching to an unsteady model.

4 MODEL RESULTS AND FLOOD HAZARD MAPPING

The hydraulic model results include water elevations in each cross-section which were translated into geospatial datasets of flood extent and depth for each of the scenarios modeled. This flood hazard mapping process was accomplished using the HEC-GeoRAS toolbar for ArcGIS which enables data transfer between GIS and HEC-RAS. Water surface profiles from the model results were exported to GIS and differenced against the underlying NOAA LiDAR topography to map flood extent. This topographic dataset does not include bathymetry below the water line thus flow depths in the channel are representative of depth above the water line at the time during which the LiDAR data were surveyed. Though some channel bathymetry for Tembladero Slough and the Reclamation Ditch was present in the original HEC-RAS model, no clear geospatial information was available for precisely locating these data. Thus the bathymetry from the cross-sections was not integrated into the topographic surface. The results of the inundation mapping are shown for the Reclamation Ditch system in Figure 11 and for Soquel Creek in Figure 12.

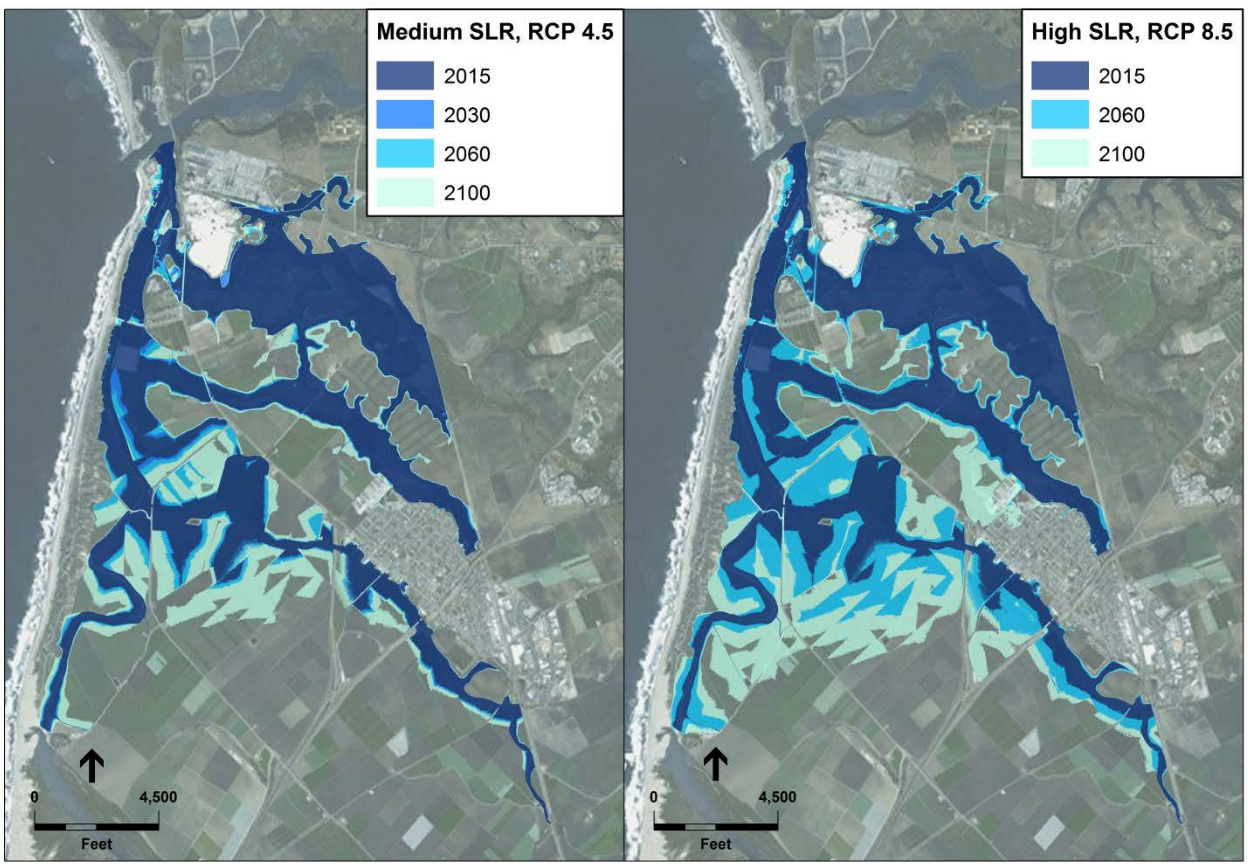

Figure 11. Flood inundation hazard maps for multiple climate scenarios on the Reclamation Ditch system

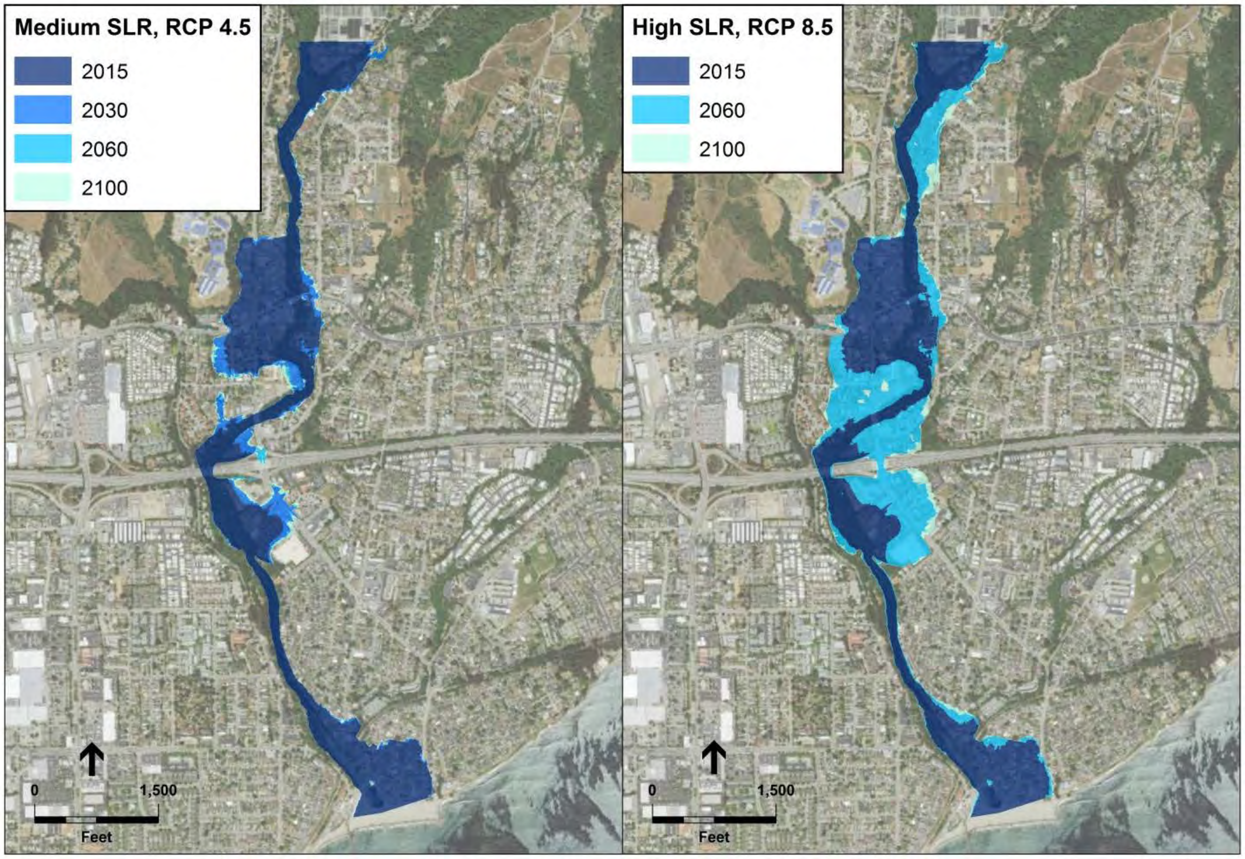

Figure 12. Flood inundation hazard maps for multiple climate scenarios on Soquel Creek

As Figure 11 shows, the flood extent increases significantly from existing conditions to 2100 on the Reclamation Ditch system. The majority of additional flooding is on the agricultural properties adjacent to Tembladero Slough and the Old Salinas River channel. The increase is exacerbated by the flatness of the terrain which results in a large increase in flooding for small increases in discharge. The additional flooded area is approximately 960 and 1740 acres for the Medium and High scenarios respectively, and the increase in flood depth is approximately 1.1 and 2.6 feet respectively. Depth measurements were sampled just upstream of the Hwy 156 crossings on Tembladero Slough.

For Soquel Creek, the change in 100-year discharge is less significant than on the Reclamation Ditch system. Additionally, the topography is more constrained in areas that are already flooded by the existing conditions 100-year flood. Thus the extent of flooding does not change as significantly on this system. The additional flooded area is approximately 18 and 65 acres for the Medium and High scenarios respectively, and the increase in flood depth is approximately 0.8 and 3.0 feet respectively.

In addition to the fluvial flood hazard mapping analysis, coastal storm flooding hazard zones were provided for the purposes of updating flooding connectivity in the Capitola and Salinas-Elkhorn areas. Coastal storm flooding hazards were previously mapped for the Monterey Bay Sea Level Rise Vulnerability Study (ESA PWA 2014) prepared for The Monterey Bay Sanctuary Foundation, and were provided in shapefile format for these two areas.

For the Capitola area (Soquel Creek), ESA provided MLML with intermediate coastal hazards shapefiles that contained separate polygons for the various hazards modeled. Equipped with the separated hazards and by using GIS data of storm drain networks and other flood management infrastructure, staff at MLML can make any warranted flood connectivity updates to the coastal flooding hazard layers provided in the MBSLR study (ESA PWA 2014). Described in the shapefile metadata, the separated versions of the coastal flooding hazards include layers for wave overtopping, wave runup, event tide flooding (100-yr tide), and erosion layers depicting eroded conditions of cliffs and dune areas (which would be considered as flooded in the future). Elevations associated with each flooding mechanism (except the erosion layers) are provided as attributes for each mechanism ("Method" in the attributes table).

As a part of a subsequent study "Economic Impacts of Climate Adaptation Strategies for Southern Monterey Bay" by ESA, The Nature Conservancy and others, flood connectivity was updated to reflect known water control structures in the area. The main structures considered are the tide gates on Tembladero Slough at Potrero Road, the Cabrillo Hwy road crest separating low lands from backwatering from the Moro Cojo Slough, and the water control structure between the Salinas Lagoon and Old Salinas channel to the north. In this update, flooding methods and associated flooding elevations for the Salinas River were altered to produce more accurate flood extents:

- Beach berm flooding – the elevation of flooding behind the beach berm at the Salinas River lagoon mouth was lowered from 4.88 m NAVD to 3.66 m NAVD (from 16ft to 12 ft) to represent the hydraulic control structure that diverts water north to the old Salinas River channel. These flooding layers also assume a 15 ft crest elevation for the levee on the north bank of the Salinas River, estimated from LiDAR.

- 100-yr tide flooding – flooding by the 100-year tide was updated to reflect the Potrero Rd tide gates and the road crest at Cabrillo Hwy, which affects primarily farmlands south of the Elkhorn Slough mouth.

The geospatial layers for the flood hazard extent and depths were compiled in an ESRI ArcGIS compatible geodatabase. The geodatabase was provided to MLML on 1/29/2016. Additionally the coastal flooding shapefiles adjusted to incorporate structural information on both systems was provided with this geodatabase. A table of the layers provided is included in Attachment A.

5 DISCUSSION

The climate analysis and hydraulic modeling show how future conditions flooding can change with increased precipitation intensity and higher coastal water levels with extreme coastal flood events. The flood hazard inundation extents can be used to inform planning efforts in the areas that are at risk of increased flooding as climate change puts added pressure on flood parameters. The range of scenarios provided allows for interpretation of potential flood risk given uncertainty in how climate will evolve. Planning efforts can be informed by considering a range of future scenarios and associated vulnerabilities, and the community's tolerance for risk, which should conceptually relate to the community's resilience.

The fluvial flood hazard maps add value to the previous coastal flooding analyses conducted by ESA by incorporating changes to watershed hydrology into the flood potential. This enables an assessment of the flood risk from combined changes in increasing coastal water levels and increased precipitation intensity. This is beneficial to communities at risk of flooding from both coastal and fluvial sources and provides a more complete set of scenarios for planning in those communities.

The resulting hazard maps can be used to assess risk as well as plan for future adaptation measures. By highlighting areas at risk currently and areas potentially at risk under different climate scenarios, communities can begin to develop and implement specific localized measures for adapting to these future risks. Future study should be considered to develop adaptation plans now that the tools for assessing risk have been developed and are available for further use.

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Monterey Bay Sea Level Rise

Climate Change Impacts on Combined Fluvial and Coastal Hazards

ATTACHMENT A

GIS Data Layers Provided With Report

Attachment A - Files transmitted via 20150126_fluvialHZ_w_Metadata.zip

Folder	Subfolder	File	Geographic Location	Type	SLR	Emissions
RecDitch_Tembladero_UTMz10						
	area					
		river100yr_floodplain_ec2010.shp	Tembladero Slough	Fluvial flooding extents polygon shapefile	none	none
		river100yr_floodplain_hi2060.shp	Tembladero Slough	Fluvial flooding extents polygon shapefile	High	RCP 8.5
		river100yr_floodplain_hi2100.shp	Tembladero Slough	Fluvial flooding extents polygon shapefile	High	RCP 8.5
		river100yr_floodplain_med2030.shp	Tembladero Slough	Fluvial flooding extents polygon shapefile	Medium	RCP 4.5
		river100yr_floodplain_med2060.shp	Tembladero Slough	Fluvial flooding extents polygon shapefile	Medium	RCP 4.5
		river100yr_floodplain_med2100.shp	Tembladero Slough	Fluvial flooding extents polygon shapefile	Medium	RCP 4.5
	depth					
		MaxDepth_100yr_ec2010.tif	Tembladero Slough	Fluvial flooding max depth raster	none	none
		MaxDepth_100yr_hi2060.tif	Tembladero Slough	Fluvial flooding max depth raster	High	RCP 8.5
		MaxDepth_100yr_hi2100.tif	Tembladero Slough	Fluvial flooding max depth raster	High	RCP 8.5
		MaxDepth_100yr_med2030.tif	Tembladero Slough	Fluvial flooding max depth raster	Medium	RCP 4.5
		MaxDepth_100yr_med2060.tif	Tembladero Slough	Fluvial flooding max depth raster	Medium	RCP 4.5
		MaxDepth_100yr_med2100.tif	Tembladero Slough	Fluvial flooding max depth raster	Medium	RCP 4.5
SoquelCreek_UTMz10						
	area					
		river100yr_floodplain_ec2010.shp	Soquel Creek	Fluvial flooding extents polygon shapefile	none	none
		river100yr_floodplain_hi2060.shp	Soquel Creek	Fluvial flooding extents polygon shapefile	High	RCP 8.5
		river100yr_floodplain_hi2100.shp	Soquel Creek	Fluvial flooding extents polygon shapefile	High	RCP 8.5
		river100yr_floodplain_med2030.shp	Soquel Creek	Fluvial flooding extents polygon shapefile	Medium	RCP 4.5
		river100yr_floodplain_med2060.shp	Soquel Creek	Fluvial flooding extents polygon shapefile	Medium	RCP 4.5
		river100yr_floodplain_med2100.shp	Soquel Creek	Fluvial flooding extents polygon shapefile	Medium	RCP 4.5
	depth					
		MaxDepth_100yr_ec2010.tif	Soquel Creek	Fluvial flooding max depth raster	none	none
		MaxDepth_100yr_hi2060.tif	Soquel Creek	Fluvial flooding max depth raster	High	RCP 8.5
		MaxDepth_100yr_hi2100.tif	Soquel Creek	Fluvial flooding max depth raster	High	RCP 8.5
		MaxDepth_100yr_med2030.tif	Soquel Creek	Fluvial flooding max depth raster	Medium	RCP 4.5
		MaxDepth_100yr_med2060.tif	Soquel Creek	Fluvial flooding max depth raster	Medium	RCP 4.5
		MaxDepth_100yr_med2100.tif	Soquel Creek	Fluvial flooding max depth raster	Medium	RCP 4.5

Key

SLR	High	high sea level rise (NRC 2012) of 159 cm by 2100, relative to 2010
	Med	medium sea level rise (NRC 2012) of 72 cm by 2100, relative to 2010
Emissions	RCP 8.5	future emissions scenario (IPCC, AR 5)
	RCP 4.5	future emissions scenario (IPCC, AR 5)

100-year fluvial flooding rasters and polygons are projected to UTM Zone 10N coordinates. Raster depths are in Feet.

Attachment A - Files transmitted via 20150129_Draft_UpdatedCoastalFloodHZ

Folder	File	Geographic Location	Type	SLR
coastal_storm_flood_MBSLR_Capitola				
subfolder "combined"	coastal_floodhz_ec2010_dissolved.shp	Capitola / Soquel Creek	Coastal Storm flooding extents	none
	coastal_floodhz_s12030_dissolved.shp	Capitola / Soquel Creek	Coastal Storm flooding extents	Low
	coastal_floodhz_s12060_dissolved.shp	Capitola / Soquel Creek	Coastal Storm flooding extents	Low
	coastal_floodhz_s12100_dissolved.shp	Capitola / Soquel Creek	Coastal Storm flooding extents	Low
	coastal_floodhz_s22030_dissolved.shp	Capitola / Soquel Creek	Coastal Storm flooding extents	Medium
	coastal_floodhz_s22060_dissolved.shp	Capitola / Soquel Creek	Coastal Storm flooding extents	Medium
	coastal_floodhz_s22100_dissolved.shp	Capitola / Soquel Creek	Coastal Storm flooding extents	Medium
	coastal_floodhz_s32030_dissolved.shp	Capitola / Soquel Creek	Coastal Storm flooding extents	High
	coastal_floodhz_s32060_dissolved.shp	Capitola / Soquel Creek	Coastal Storm flooding extents	High
	coastal_floodhz_s32100_dissolved.shp	Capitola / Soquel Creek	Coastal Storm flooding extents	High
subfolder "separated"	coastal_floodhz_ec2010.shp	Capitola / Soquel Creek	Coastal Storm flooding extents, with separate EL and HZ type attributes	none
	coastal_floodhz_s12030.shp	Capitola / Soquel Creek	Coastal Storm flooding extents, with separate EL and HZ type attributes	Low
	coastal_floodhz_s12060.shp	Capitola / Soquel Creek	Coastal Storm flooding extents, with separate EL and HZ type attributes	Low
	coastal_floodhz_s12100.shp	Capitola / Soquel Creek	Coastal Storm flooding extents, with separate EL and HZ type attributes	Low
	coastal_floodhz_s22030.shp	Capitola / Soquel Creek	Coastal Storm flooding extents, with separate EL and HZ type attributes	Medium
	coastal_floodhz_s22060.shp	Capitola / Soquel Creek	Coastal Storm flooding extents, with separate EL and HZ type attributes	Medium
	coastal_floodhz_s22100.shp	Capitola / Soquel Creek	Coastal Storm flooding extents, with separate EL and HZ type attributes	Medium
	coastal_floodhz_s32030.shp	Capitola / Soquel Creek	Coastal Storm flooding extents, with separate EL and HZ type attributes	High
	coastal_floodhz_s32060.shp	Capitola / Soquel Creek	Coastal Storm flooding extents, with separate EL and HZ type attributes	High
	coastal_floodhz_s32100.shp	Capitola / Soquel Creek	Coastal Storm flooding extents, with separate EL and HZ type attributes	High
event_flood_SMB_SalinasElkhorn				
subfolder "combined"	event_flood_AER_ec2010.shp	Salinas River / Elkhorn Sloug	Coastal Storm flooding extents	none
	event_flood_AER_s22030.shp	Salinas River / Elkhorn Sloug	Coastal Storm flooding extents	Medium
	event_flood_AER_s22060.shp	Salinas River / Elkhorn Sloug	Coastal Storm flooding extents	Medium
	event_flood_AER_s22100.shp	Salinas River / Elkhorn Sloug	Coastal Storm flooding extents	Medium
	event_flood_AER_s32030.shp	Salinas River / Elkhorn Sloug	Coastal Storm flooding extents	High
	event_flood_AER_s32060.shp	Salinas River / Elkhorn Sloug	Coastal Storm flooding extents	High
	event_flood_AER_s32100.shp	Salinas River / Elkhorn Sloug	Coastal Storm flooding extents	High
subfolder "separated"	event_flood_AER_ec2010_EL.shp	Salinas River / Elkhorn Sloug	Coastal Storm flooding extents, with separate EL and HZ type attributes	none
	event_flood_AER_s22030_EL.shp	Salinas River / Elkhorn Sloug	Coastal Storm flooding extents, with separate EL and HZ type attributes	Medium
	event_flood_AER_s22060_EL.shp	Salinas River / Elkhorn Sloug	Coastal Storm flooding extents, with separate EL and HZ type attributes	Medium
	event_flood_AER_s22100_EL.shp	Salinas River / Elkhorn Sloug	Coastal Storm flooding extents, with separate EL and HZ type attributes	Medium
	event_flood_AER_s32030_EL.shp	Salinas River / Elkhorn Sloug	Coastal Storm flooding extents, with separate EL and HZ type attributes	High
	event_flood_AER_s32060_EL.shp	Salinas River / Elkhorn Sloug	Coastal Storm flooding extents, with separate EL and HZ type attributes	High
	event_flood_AER_s32100_EL.shp	Salinas River / Elkhorn Sloug	Coastal Storm flooding extents, with separate EL and HZ type attributes	High

Key

SLR	low sea level rise (NRC 2012) of 22 cm by 2100, relative to 2010
	medium sea level rise (NRC 2012) of 72 cm by 2100, relative to 2010
	high sea level rise (NRC 2012) of 159 cm by 2100, relative to 2010

coastal storm flooding rasters and polygons are projected to UTM Zone 10N coordinates

Appendix D – City of Capitola Notice of Availability of Public Review Draft 2020 LHMP

Advance Planning - LHMP Public Comment Period Now Open

ADVANCE PLANNING OVERVIEW

Advance Planning maintains and updates the City's long-range planning documents, including the **General Plan**, **Housing Element**, **Zoning Code**, **Local Coastal Program**, and design guidelines. Advance Planning functions also include policy and ordinance development, coordination with neighboring agencies on regional planning issues, and grant preparation and administration.

ADVANCE PLANNING PROJECTS

Local Hazard Mitigation Plan Update - Public Comment Period Now Open

The City is currently in the process of updating the Local Hazard Mitigation Plan. The public comment period will be open from April 15, 2020 through April 29, 2020. Please submit written comment to planning@ci.capitola.ca.us.

Draft Local Hazard Mitigation Plan for public comment period

The purpose of the LHMP is to develop a comprehensive local public planning process to assess and develop a response to the city's vulnerability to natural hazards. The LHMP identifies critical facilities that are vital to the city's and other local agencies' response during a natural disaster, particularly those that are currently vulnerable or at risk, assesses vulnerability to a variety of natural disasters (earthquake, flood, coastal erosion, etc.) and identifies needed mitigation actions.